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A National Environmental/Energy Workforce Assessment. Post-Secondary Education Profile Composite I (Cont'd) (Environmental Engineering/Health)

National Field Research Center, Inc., Iowa City, IA

Prepared for

Environmental Protection Agency, Washington, DC

Dec 78

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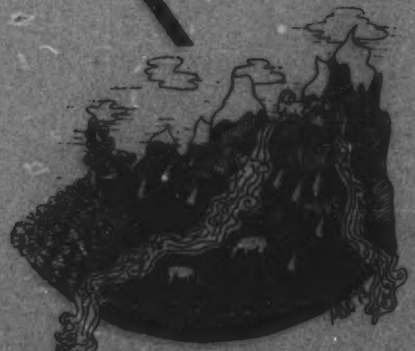
Post Secondary
Education Profile

COMPOSITE I (cont'd)
(Environmental Engineering/Health)

Phase II
Of A National Environmental/Energy Workforce Assessment



Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.
P. O. Box 287
Iowa City, Iowa 52240

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16. ABSTRACT

This study is one of 16 volumes aggregating data on representative environmental education offerings in the United States at post-secondary education institutions and in the private sector of the economy. Structured around on-site interviews, the study describes the institutions' education programs — their program structure, representative course offerings, faculty structure, and program requirements. In addition, the study provides information on the employment history of graduates.

Designed as Phase II of a three-phase program, the study presents the information on schools in the following volumes: two volumes on potable water and two on wastewater; one volume each on air, noise, pesticides, radiation, solid waste and energy; a two-volume composite report on environmental engineering/health; a one-volume report on education/ecology; and a volume on some training programs conducted by businesses and by trade and professional associations. In addition, the study includes a one-volume abstract and a one-volume summary. The study is an overview. It doesn't include all environmental programs in the United States, and it makes no attempt to evaluate the program offerings.

Phase I of the study assessed the workforce needs (manpower needs) for pollution control and abatement in the United States for the five-year period of 1976 through 1981. Phase III, which will be available in September 1979, will offer recommendations, curriculum changes, and modifications that appear necessary to assure a properly trained national environmental workforce

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PHASE II

POST-SECONDARY EDUCATION PROFILE

COMPOSITE 1

(Environmental Engineering/Health)

(con't.)

Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.

Under Grant from:

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National
Field
Research
Center, Inc.

P.O. BOX 287
IOWA CITY, IA 52240
(319) 351-8789

HEADQUARTERS
- IOWA CITY -
P.O. BOX 287
IOWA CITY, IA 52240
(319) 351-8789

FIELD OFFICES
- ATLANTA -
2700 CUMBERLAND PKWY
SUITE 150
ATLANTA, GA 30339
(404) 433-2644

- DENVER -
2600 S. PARKER ROAD
SUITE 160, NO. 6
DENVER, CO 80232
(303) 751-4952

- WASHINGTON, D.C. -
1522 K STREET, N.W.
SUITE 600
WASHINGTON, DC 20005
(202) 223-9138

AFFILIATE OFFICES
- CHICAGO -
P.O. BOX 57A
WHEELING, IL 60090
(312) 537-8988

- SPRINGFIELD -
22 DOWNING DRIVE
CHATHAM, IL 62629
(217) 483-2751

INTRODUCTORY NOTE

The National Environmental/Energy Workforce Assessment: Post-Secondary Education Profile was conducted by National Field Research Center, Inc. with main offices in Iowa City, Iowa. The following personnel have had primary responsibility for the development of the project report.

IOWA CITY, IOWA
Dr. Darold E. Albright, President
Paul E. Bridges, Executive Director
D. Peter Wahl, Project Director
Janet M. Henry
Amy W. Mook
Mary Kay (Edge) Wade

ATLANTA, GEORGIA
Elizabeth G. Nielsen, Regional Director
Marilyn J. Horton

DENVER, COLORADO
Nancy C. Dillenberg, Regional Director
Bruce D. Boxer

WASHINGTON, D.C.
Frank E. Smith, Project Coordinator
Jack F. Seum, Regional Director
Robert D. Oxberger
Dr. Constance Swank

Additional research and clerical assistance was provided by Margaret Fehn, Barbara Friedman, Cynthia Fruendt, Gail Gronlund, Karen Kirchoff, Sharon Leiker and Mary McCormac.

VOLUME I (cont'd)

Envrionmental Engineering/Health - Volume I (cont'd) contains summaries of those post-secondary training programs which, due to space limitations, could not be included in Volume I. Appendices relevant to both volumes are included in Volume I (cont'd). These Engineering/Health volumes represent a single set and are not intended to be distributed or read as independent volumes.

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DOCUMENT COMPLETE - PAGINATION PER SOURCE

INSTITUTION: OHIO STATE UNIVERSITY

PROGRAM: Agricultural Engineering*

DEPARTMENT: Agricultural Engineering

DEGREE: Bachelor of Science
Master of Science
Doctor of Philosophy

CONTACT: Dr. Gordon Nelson, Chairman
Department of Agricultural Engineering
105 Ives Hall
Ohio State University
Neil Avenue
Columbus, Ohio 43210
(614) 422-6131

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

In existence since 1970, pollution-related courses in Agricultural Engineering at Ohio State University originally emphasized engineering and livestock waste. Now, however, the focus is expanding to include sediment and municipal waste and sludge pollution. Three degree programs are available in Agricultural Engineering: B.S., M.S., and Ph.D. Students enrolled in these programs learn "to design, develop, and test new or improved agricultural machines; to devise new ways of processing agricultural products on the farm and in food plants; new engineering methods for soil and water resource conservation; and structures and systems to create optimum environments for animal or plant growth." Areas of emphasis in graduate work include: livestock waste engineering, hydrology of non-point pollution sources; odor identification and control; livestock environment analysis and modification; plant environment engineering; soil and water engineering; systems for land application of municipal sewage sludge; and food processing plant waste engineering."

Research facilities include the North Appalachian Experimental Watershed at Coshocton, Ohio, where studies on "agricultural watershed hydrology in relation to environmental effects" are conducted; and the Pioneering Research Laboratory at the Ohio Agricultural Research and Development Center at Wooster, Ohio, that is "engaged in basic studies of aerosol and gaseous constituent transport in relation to the environment of plant canopies." The Department maintains a facility for "laboratory studies of livestock waste treatment at Ives Hall" and "an experimental lagooning installation for storing liquid livestock waste for use in irrigation, and experimental disposal field."

With the Ohio Extension Service, the Department conducts continuing education courses and workshops for professionals and paraprofessionals in and out of the state. Topics have included domestic and residential sewage disposal, wastewater, and drainage. Staff personnel are currently in the process of setting up a cooperative work program for students who until this time were dependent on summer jobs for professional experience during their schooling.

Federal and state monies have supported recent pollution-related research in the Department. The Hatch Act appropriation has given funding to the Agricultural Experiment Station for study on water quality as affected by crop culture and animal occupancy. Special monies from the State of Ohio have supported investigations of cost/effective livestock management systems to control pollution and of the effect of pasturing on non-point surface runoff. A recently submitted proposal to the Environmental Protection Agency asks for funding of an interdisciplinary project involving government, university, and experiment station resources in demonstrating the best management systems for disposal of animal wastes.

PROGRAM REQUIREMENTS

Students must complete 215 quarter hours (40 in Agricultural Engineering, 16 Technical Electives) to obtain the B.S. degree. A minimum master's degree program (45 hours with thesis, 50 hours without thesis) must contain at least "15 hours of advanced basic science, such as mathematics, physics, or biology," "6 hours of 500-level or higher mathematics, and one graduate-level three-course sequence in the area of specialization." A doctoral candidate "must offer in-depth preparation in a recognized area of specialization related to agricultural engineering, plus supporting work in research tools and concepts such as mathematics, statistics, physics, engineering sciences, and biological sciences to enable the student to plan research and to analyze and interpret research results."

CURRENT FACULTY, STUDENTS, GRADUATES

Approximately twelve faculty members (in Columbus or Wooster) devote some portion of their time to environmental concerns. Their areas of expertise include soil and water management, pesticide application, environmental interaction modeling, watershed hydrology, benefit appraisal and assessment procedure to implement projects under Ohio drainage laws, rural domestic and agricultural uses of water, effects of environmental stress on swine and other farm animals, water quality, agricultural pollution control, waste utilization, and waste management.

There are eighty undergraduates and eight M.S. and fourteen Ph.D. candidates in the program at present. Numbers of graduates annually have been stable over the last few years (18-20 B.S., 3 M.S., and 4 Ph.D.). Eighty percent of the graduate students receive financial support from appropriated monies or industrial grants; the remainder are self-supporting or in the case of any foreign students, sometimes supported by home governments or universities.

Employment possibilities are extensive with approximately 15% of the B.S. and M.S. students pursuing advanced degrees, 55% entering private sector jobs, and 30% entering industry. Ph.D. graduates seek employment in universities with Agricultural Engineering Departments. Undergraduates "find employment as engineers with agencies such as: Soil Conservation Service, Environmental Protection Agency (federal and state), consulting engineering firms, and manufacturers of equipment and systems for agricultural environmental and pollution-related applications." Individuals with advanced degrees are employed by the U.S. Department of Agriculture, Environmental Protection Agency, WHO-UN, consulting engineering firms, and manufacturers of environmental systems and equipment.

PROGRAM PROJECTIONS

The Agricultural Engineering program at Ohio State adapts to changing social problems and crises. Currently, training has reflected a response to the environmental crisis; necessary future responses to energy, food, and water emergencies will undoubtedly expand and modify the curriculum. No faculty or staff increases are anticipated, and student enrollment should remain stable or increase.

COURSE DESCRIPTION**

Agricultural Engineering:

535 Utilization of Energy in Agriculture - Study of motive and stationary power needs of agriculture, mechanics of traction, characteristics of power sources, morphology of off-the-road vehicle design. (U G 4 q.h.)

543 Engineering Soil-Water Management - Engineering design of drainage, irrigation, and erosion control systems for optimum crop growth, environment, and related water storage structures. (U G 5 q.h.)

645 Environmental Engineering of Agricultural Structures - Functional requirements and principles involved in housing animals and crops; analysis of factors and properties affecting energy exchanges with the environment. (U G 4 q.h.)

657 Soil Machine Dynamics in Plant Environment - Soil dynamics in relation to plant environment and agricultural machine design. (U G 4 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (U G 5 q.h.)

750 Design of Waste Management Systems - Application of bioengineering principles of pollution control in the design of management systems for wastes from food and fiber production, storage, and processing operations. (U G 3 q.h.)

877 Drainage Engineering - Principles of water movement to subsurface drains including depth and spacing; frequency analysis of drainage

877 (Cont'd) - flow; hydrologic characteristics of drainage systems; drainage requirements of crops. (G 3 q.h.)

*Sources: The Ohio State University Bulletin (Graduate School, College of Engineering, Course Offerings) 1976-78; Environmental Programs and Activities at The Ohio State University (September 1976).

**U = undergraduate level course; G = graduate level course

INSTITUTION: OHIO STATE UNIVERSITY

PROGRAM: Civil Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science, Hydraulics Engineering-Hydrology (B.S.); Bachelor of Science, Sanitary Engineering (B.S.); Master of Science & Doctor of Philosophy, Environmental & Water Chemistry (M.S., Ph.D.); Master of Science & Doctor of Philosophy, Hydrology & Hydraulic Engineering (M.S., Ph.D.); Master of Science & Doctor of Philosophy, Sanitary & Environmental Engineering (M.S., Ph.D.); Master of Science, Civil Engineering & Public Administration (M.S.)-Public Works Administration/Environmental & Engineering Management; Doctor of Philosophy, Civil Engineering (Ph.D.)

CONTACT: Dr. Otis J. Sproul, Chairman
Department of Civil Engineering
Ohio State University
470 Hitchcock Hall
Columbus, Ohio 43210
(614) 422-2771

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The current College of Engineering Catalogue summarizes well the undergraduate Civil Engineering curriculum and its environmentally related program options. It notes:

> The future civil engineer needs to be versed in a number of disciplines in order to cope with the various problems he will encounter in the practice of his profession. In the civil engineering curriculum at The Ohio State University, the student studies fundamental methematics and science, on which much of engineering is based; social sciences and humanities, to broaden his perspective and to prepare him for professional interaction with people; a core of basic civil engineering subject areas, including courses in transportation, structures, water resources, materials, and applied mathematics; and a personally tailored group of electives in the student's selected area of concentration.

Major elective options available to students in the undergraduate Civil Engineering program include:

Sanitary Engineering--distribution and collection, design of treatment facilities
Hydraulic Engineering and Hydrology--hydraulics, hydrology, fluid mechanics, water resource systems analysis
Environmental and Engineering Surveys--surveying, photogrammetry, remote sensing

The graduate level offerings in the department are likewise varied. To obtain a Master of Science or Doctor of Philosophy degree in Civil Engineering, students must complete a minimum number of courses in an area of specialization; among these are areas of emphasis in Environmental and Water Chemistry, Hydrology and Hydraulic Engineering, and Sanitary and Environmental Engineering. A dual M.S. degree program with the Department of Public Works Administration is designed for those persons seeking administrative and technical positions with state and federal environmental protection agencies and private consulting engineering companies.

Students in these Civil Engineering programs utilize numerous facilities and laboratories on the Ohio State University campus. With the City of Columbus, the Water Resources Center is now building some pilot-plant equipment to be used in water treatability research. An Engineering Experiment station administers sponsored research and service programs throughout the College of Engineering, and in addition to the Water Resources Center, maintains a 10 K.W. Nuclear Reactor, and a Transportation Research Center. The CLEAR (Center for Lake Erie Area Research) project maintains a laboratory at Put-in-Bay on Lake Erie which is open to OSU students and staff. The Department of Civil Engineering also sponsors short courses for practitioners on such topics as design procedures, environmental impact statements, small dam design, and hydrology of lakes.

Currently faculty research projects are funded by both the Ohio and the U.S. Environmental Protection Agencies, Office of Water Research and Technology, Engineering Experiment Station, International Joint Commission, City of Columbus, Battelle Memorial Institute, the U.S. Army Corps of Engineers, and the U.S. Army Research and Development Command. Topics and/or areas of interest include: gas movements in sanitary landfills; fluid mechanics laboratory apparatus; prediction of nutrient, oxygen, plankton, and sludge distributions in a stratified euthropic lake; Lake Erie shore erosion damage; mechanism of soil erosion by runoff; predictive and pollution abatement modeling for mine drainage; mechanism of ozone inactivation of waterborne viruses, recovery of ultrafine coal particles by microflotation; integration and synthesis of watershed studies on the effects of land use on pollutant loadings to Lake Erie; assessment impacts of energy conversion on the environment of the Ohio River Basin; inactivation of cysts with cynauric acid compounds; and elimination of filamentous blue-green algae at the Southerly Sewage Treatment Plant (Columbus).

PROGRAM REQUIREMENTS

To complete the B.S. degree program in Civil Engineering, a student must obtain a minimum of 200 quarter hours of credit. In addition to a set of core courses, undergraduates must take 31 hours in Major Option and Professional Electives in the third and fourth years. Major options (e.g., sanitary engineering) include specific required courses (approximately 14 hours) and recommended courses for Professional Electives. It is possible to count the required courses in one Major Option as Professional Electives in another Major Option. In exceptional cases, a student may work with the faculty advisor to design an honors program for the entire 31 required credit hours.

A baccalaureate degree in Civil Engineering for an Engineering Council for Professional Development accredited curriculum satisfies the admission requirements for graduate study. Applicants with other baccalaureate degrees in engineering, in allied fields, or from non-accredited curricula will be considered for admission in accordance with the College of Engineering admission policy guidelines. Such students may be required to take additional courses depending upon their preparation and objectives.

To obtain an M.S. degree in Civil Engineering, students must complete a minimum total of 45 graduate credit hours of coursework and 9 graduate credit hours of thesis. (A non-thesis, 50 graduate-credit hour plan is permitted only in exceptional cases of wide professional experience.) The Ph.D. in Civil Engineering requires 135 graduate hours beyond the baccalaureate (90 hours of coursework and 45 hours of dissertation). Individual options at the doctoral level require certain components of courses and levels.

The dual-master's degree program offered by the Departments of Civil Engineering and Public Works Administration awards candidates the degrees of Master of Science in Civil Engineering and Master of Public Administration upon completion of the program. Students are expected to complete a minimum of 78 hours in both departments. A thesis is not required, but it is expected that an original Policy Paper will be completed during the second year of the program as an integral part of the Policy Problems Seminars (PA 850 and 851). This paper, in addition to fulfilling the course requirement, must be reviewed for approval by a faculty member of the Department of Civil Engineering and the Division of Public Administration. Summer internships are encouraged in this dual program.

CURRENT FACULTY, STUDENTS, GRADUATES

There are seven faculty members in Civil Engineering involved with the programs included in this summary, six of whom split their time evenly between teaching and research, one who is a full-time administrator but devotes 20-30 percent of his time to research, and one who is one-half time in administration but spends 20 percent of his time on research. In the Hydraulics/Hydrology, Sanitary Engineering, and Environmental Engineering Major Options, there are 32 seniors currently enrolled. In the relevant graduate study areas, there are 21 M.S. and five Ph.D. candidates. On the average, the program awards 32 B.S., six to eight M.S. and one Ph.D. degree. Undergraduate and graduate enrollment levels are increasing. Graduates are employed in the private sector (55 percent) and government (45 percent), and the placement record of the department is excellent. Standard grant programs exist for undergraduates, while financial aid to graduate students consists of research grant support and teaching assistantships (80-85 percent) and outside employment or home government subsidies (15-20 percent).

PROGRAM PROJECTIONS

The long-range goals of the Civil Engineering program include increased curriculum offerings and research in remote sensing, hydrology and hydromechanics - all key environmental areas. While the current program is expected to continue, two faculty members (in environmental survey, hydromechanics and hydrology) must be added and laboratory space and support expanded if the status quo is to be maintained. New staff and facilities would vastly increase the capabilities of the department to prepare students for the major, regional environmental questions they must face and answer. Change in environmental programs generally will, in all probability, come in emphasis and not in greater student enrollments.

COURSE DESCRIPTION (SELECTED)*

Civil Engineering:

410 Environmental Pollution and Control - Environmental pollution: the causes and control of air, water, and land pollution in relation to their effects on health, aesthetics, economics and ecology. (U 3 q.h.)

460 Professional Aspects of Civil Engineering - Structure of the civil engineering profession; interaction of civil engineers with the education process, their clients, other professions and the public. (U 1 q.h.)

518 Environmental Quality - Introduction to environmental quality; air pollution; solid waste disposal; water quality and treatment; wastewater characteristics and treatment. (U G 4 q.h.)

519 Applied Hydraulics - Applied fluid mechanics including pressure probes, open and closed conduit flow measurement and devices; tubo-machinery, homologous units, characteristic curves; water hammer; surge; conduits; laboratory experiments. (U G 3 q.h.)

521 Water Distribution and Wastewater Collection - Design of water supply collection, transmission and distribution systems; design of sewage and storm water collection and disposal systems.(UG3qh)

540 Civil Engineering Systems - Basic concepts and methods of systems engineering and application to civil engineering problems in transportation and water resources planning, structural design, and construction management. (U G 4 q.h.)

576 Civil Engineering Economics and Planning - Engineering economics and theories of planning applied to private and public civil works. (U G 4 q.h.)

603 Remote Sensing of Environment - The energies of the natural and cultural environment; current remote sensing systems and case histories of applications in measuring the environment. (U G 4 q.h.)

610 Analysis of Natural and Polluted Waters - A laboratory study of the measurement and interpretation of water quality indices and pollution, parameters including BOD, COD, alkalinity, nutrients, pH, and heavy metals. (U G 4 q.h.)

613 Applied Hydrology - Hydrologic cycle, meteorology, streamflow, evapotranspiration, hydrographs, runoff relations, runoff hydrographs, groundwater, unit hydrographs, flood routing, frequency and duration studies, and application of hydrologic techniques. (U G 4 q.h.)

614 Transport Phenonmena in Water Resources Engineering - Momentum mass and energy transfer; dimensional analysis; laminar and turbulent transport and mixing; techniques applied to water environment; contaminated transport and hydrodynamics, stratification, and outfall mixing. (U G 4 q.h.)

618 Design of Treatment Facilities - Selection and design of processes for the purification of drinking water and the treatment of wastewaters. (U G 4 q.h.)

624 Coastal and Ocean Engineering - Elementary linear and nonlinear wave theory; wave forecasting spectra; forces on fixed submerged structures; beach processes, littoral drift and sediment transport; shore line protection; coastal outfalls and intakes. (U G 4 q.h.)

677 Noise, Pollution and Safety Aspects of Transportation Systems - Vehicle noise and emissions as affected by operating characteristics; noise measurement and abatement techniques; air quality legislation, air pollution; traffic accident analysis. (U G 4 q.h.)

713 Environmental Engineering Measurements - The application of advanced physical and chemical measurement and calculation techniques to environmental engineering problems. (U G 4 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, principles, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (U G 5 q.h.)

715 Water Resource Systems: Water Quantity - Planning, design, and operation of reservoirs for single and multiple-purpose use, flood estimation and management alternatives, conjunctive use of ground and surface waters. (U G 4 q.h.)

717 Industrial and Municipal Solid Waste Disposal - Characterization and sources of solid waste; solid waste management; collection systems; processing and disposal; and recycle. (U G 3 q.h.)

719 Stream Sanitation - A study of stream quality standards; effluent standards; and the assimilative capacity of natural water bodies. (U G 4 q.h.)

720 Water Resource Systems: Water Quality - Mathematical modeling of conservative and non-conservative pollutants in aquifers, streams, lakes, estuaries and coastal waters and methods for obtaining least cost correction measures. (U G 4 q.h.)

721 Design of Hydraulic Structures - Basic engineering economic studies, water laws design concepts, reservoir engineering, river training, spillways and energy dissipators; irrigation structures, and channel transition design. (U G 4 q.h.)

724 Dynamic Oceanography - Physical and chemical properties of pure and sea water; global energy balance, governing equations, ocean statics, circulation features, stratification, chloride and pollutant distribution; tide prediction and measurement. (U G 4 q.h.)

755 Solid Waste as a Construction Material - Solid waste material characteristics, production and availability; physical-chemical nature; application in soil stabilization, embankment construction, asphaltic pavements and concrete mixtures. (U G 3 q.h.)

795 Seminar in Civil Engineering - Lectures and discussions of current topics related to civil engineering presented by faculty, students, and guest speakers: term paper required. Repeatable to maximum of 3 credit hours. (U G 1 q.h.)

804 Water Resources Engineering Applications of Remote Sensing - Principles and techniques of using remote sensing for acquisition of data in water resources engineering projects and water quality investigations. (G 5 q.h.)

810 Physical Water and Wastewater Treatment Processes - Principles and design of physical processes for water and wastewater treatment including screening, sedimentation, mixing, floatation, and filtration. (G 3 q.h.)

811 Biological Wastewater Treatment Processes - Principles and design of biological processes for wastewater treatment (G 5 q.h.)

812 Chemical and Advanced Wastewater Treatment Processes - Principles of physical-chemical treatment processes for water and wastewater, including coagulation, softening, absorption, nutrient removal and disinfection. (G 5 q.h.)

814 Industrial Wastewater Treatment - Principles of industrial wastewater treatment including wastewater surveys; flow reduction, and segregation and equalization; batch and continuous treatment; instrumentation, and treatment processes. (G 3 q.h.)

820 Advanced Hydrology - Advanced analysis of classical concepts; study of new techniques and concepts developing in modern hydrology; written and oral presentations of critical reviews of current literature. (G 5 q.h.)

850 Seepage in Permeable Materials - Analysis of seepage volume and stresses in connection with excavation, dams, wells, slopes, and subsurface drainage; electro-osmosis. (G 4 q.h.)

Agricultural Engineering:

750 Design of Waste Management Systems - Application of bioengineering principles of pollution control in the design of management systems for wastes from food and fiber production, storage, and processing operations. (U G 3 q.h.)

Chemical Engineering:

671 Legal Aspects of Engineering - Basic legal concepts; the administrative processes as exemplified by environmental regulation; patents, trade secrets; selected topics from the viewpoint of the engineer and scientist. (U G 3 q.h.)

771 Air Pollution - Sources of air pollutants, properties of small particles, chemistry of air pollution, dispersion and deposition of air pollutants, and air pollution control. (U G 3 q.h.)

Geography:

530 Conservation of Natural Resources - Philosophy of resource use; appraisal of resource base; costs of resource development and conservation; resource perception, utilization and alternatives. (U G 4 q.h.)

650 Urban Geography - Origin and growth of cities; structure and function of urban centers, their areal expansion, and intertrade center relations, each examined in relation to city planning. (U G 5 q.h.)

Law:

719 Natural Resources - The nature and incidents of public and private interests in water, minerals, oil and gas; conveyancing of natural resources, and mineral, oil and gas leasing. (P 4 q.h.)

732 Environmental Law - Legal problems relating to the living environment; legal problems of conservation of resources such as forest, wildlife, soil and parks. (P 3 q.h.)

Mechanical Engineering:

636 Nuclear Power Plants - A study of the thermal and mechanical design aspects of nuclear power plants and processes. (U G 3 q.h.)

640 Principles of Environmental Control - A study of the principles of the control of environments for human occupation, occupation by other living beings, the operations of mechanical and electrical equipment, and for the storage and processing of materials. (U G 3 q.h.)

Microbiology:

634 Water Microbiology - A basic study of the relationships and influence of aquatic environments on micro-organisms and the effect of microbial metabolic processes on the quality of water. (U G 5 q.h.)

Natural Resources:

600 Natural Resources Problems, Programs, and Policies - Analytical study of contemporary and future problems of natural resources conservation and programs and policies related to their solution. (U G 4 q.h.)

Nuclear Engineering:

505 Introduction to Nuclear Science and Engineering - Discussions of nuclear energy and nuclear radiation; sources, methods of utilization, and projections for future engineering uses. (U G 3 q.h.)

606 Radiological Safety - General principles of radiation, radioactivity, and protection methodology with emphasis on approved operating, handling and waste disposal procedures, also regulations and biological effects. (U G 3 q.h.)

626 Introduction to Nuclear Power - Nuclear power reactors; the economic and technical aspects of the nuclear power industry. (U G 3 q.h.)

*Instructional Level:
U = Undergraduate
G = Graduate
P = Professional

INSTITUTION: OHIO STATE UNIVERSITY

PROGRAM: Environmental Biology

DEPARTMENT: College of Biological Sciences

DEGREE: Master of Science
Doctor of Philosophy

CONTACT: Dr. Emanuel D. Rudolph, Director
Dr. Sheldon I. Lustick
Environmental Biology Program
College of Biological Sciences
Ohio State University
1735 Neil Avenue
Columbus, Ohio 43210 (614) 422-5306

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Biology program at Ohio State University, according to its 1976-77 Annual Report, is designed "to provide educational and research opportunities for a limited number of graduate students who desire a background in biological understanding as it relates particularly to problems concerning the environments of organisms and biological systems." Students may pursue M.S. or Ph.D. degrees and construct their plans of study from a list of environmentally-related courses offered across the campus. The curriculum is broadly oriented insuring that students receive both basic and applied science training and flexible enough to permit a varied scope depending on one's career goals.

Research opportunities are diverse. A list of current or recent projects would include: the ecology of aquatic insects, factors affecting lake eutrophication, the measurement of fitness in natural communities, the physiological and biochemical ecology of microorganisms, analysis and dynamics of terrestrial ecosystems, the physiology of environmental stress, the evolution of fitness in animal populations, the productivity and population biology of aquatic ecosystems, and the ecology and phytogeography of polar regions. Field research may encompass "a variety of local habitats, or range as far as the tropics and polar regions."

Facilities available to students and faculty include laboratories on islands in Lake Erie; the Neotoma Bioclimatic Laboratory equipped with environmental sensing devices; the Institute of Polar Studies providing a unique access to research in polar regions; the Ohio Cooperative Wildlife Research Unit with several natural areas and research stations, vehicles, and laboratory facilities (e.g., gas chromatographs, liquid scintillation spectrometer, atomic absorption spectrometer, and a pulse height analyzer); the Ohio Cooperative Fisheries Unit; and the

Acarology Lab supporting both the applied and theoretical study of acarine biology.

The Environmental Biology Program co-sponsors an annual conference on an environmental topic with the Ecology Committee of the Ohio Academy of Sciences, the Battelle Columbus Laboratories, and the Ohio Biological Survey. Recent symposia have centered on the topics "Environmental Impact Assessment: the Role of Biologists" and "Stress Effects on Natural Ecosystems." Both faculty and students are encouraged to take an active part in these proceedings.

The program has received funding from within and outside the University. Sources of support include the National Science Foundation, Environmental Protection Agency, Department of the Interior, Atomic Energy Commission, American Electric Power Service Company and CLEAR (Center for Lake Erie Area Research).

PROGRAM REQUIREMENTS

Applicants to the Environmental Biology Program should have either an undergraduate major in the biological sciences or a major in one of the physical sciences with a strong foundation in the biological sciences. Basic competence in chemistry, physics, and mathematics is required; and students with a deficiency may be admitted on probation until the deficiency is removed.

Although M.S. and Ph.D. degrees are offered, capable students are encouraged to pursue the doctoral degree. Candidates for the master's degree have two options: thesis (45 credit hours of coursework) or non-thesis (50 credit hours of coursework). Most studies in the Environmental Biology program require a thesis, with only unusual cases of specialized training being substituted for a thesis. At least two quarters (for M.S.) and five quarters (for Ph.D.) of participation in the Environmental Biology Seminar are also required. All courses, except for the Environmental Biology Seminar, are decided upon by the student and advisor and drawn from a master list of relevant O.S.U. courses. Students must demonstrate a comprehensive knowledge of one modern foreign language or a meaningful substitute (e.g., computer language) as determined by the student's advisory committee.

CURRENT FACULTY, STUDENTS, GRADUATES

The interdepartmental nature of the program makes any count of participating faculty in Environmental Biology difficult, but current bulletins indicate 18-20 staff members are primarily involved. There are fourteen Environmental Biology graduate students and an additional 100 undergraduates whose major programs are oriented to ecological studies. Financial support to students includes 2-4 teaching assistantships through the College of Biological Sciences, several research assistantships through faculty grants, two O.S.U. fellowships, and funding from CLEAR.

An average of seven students complete their degrees annually. Employment opportunities include work in government at state and federal levels, drafting environmental impact statements, and teaching. Faculty contend that the broader the range of training, the better the student's chances of getting a job. Though no formal internship program exists at the graduate level, it might make job placement easier.

PROGRAM PROJECTIONS

The stability of the Environmental Biology Program at Ohio State depends on several factors. One, funding is needed to upgrade the program and maintain its breadth. According to faculty personnel, government grants tend to be unfortunately narrow and geared to specific problems rather than to the environmentalist's general field and his/her ability to foresee problems. Without funding, the future is dim. Two, with the majority of graduates seeking applied-science employment, the healthy shift by industry and consulting firms to hire "broad-view," adequately trained students will prove increasingly beneficial. Three, the attraction of society in the early 1970's to environmental education programs waned with the energy crisis in recent years. However, faculty project a renewed concern with the environment when we realize how our strip mining and energy measures are altering it.

COURSE DESCRIPTION

Agricultural Engineering:

543 Engineering Soil-Water Management - Engineering design of drainage, irrigation, and erosion control systems for optimum crop growth, environment, and related water storage structures. (5 q.h.)

645 Environmental Engineering of Agricultural Structures - Functional requirements and principles involved in housing animals and crops; analysis of factors and properties affecting energy exchanges with the environment. (4 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (5 q.h.)

750 Design of Waste Management Systems - Application of bioengineering principles of pollution control in the design of management systems for wastes from food and fiber production, storage, and processing operations. (3 q.h.)

877 Drainage Engineering - Principles of water movement to subsurface drains including depth and spacing; frequency analysis of drainage flow; hydrologic characteristics of drainage systems; drainage requirements of crops. (3 q.h.)

Agricultural Mechanization and Systems:

550 Pollution Control and Waste Utilization - Management and utilization of animal wastes, fertilizers, pesticides, crop residues, milk and food processing and farmstead and urban solid wastes to abate environmental pollution at the urban-rural interface. (3 q.h.)

570 Agricultural and Forest Hydrology - Hydrology of small watersheds as influenced by watershed management practices; water resource development; control of sediment and floods; and water quality conservation. (3 q.h.)

Chemical Engineering:

571 Air Pollution - Sources and dispersion of air pollutants, air pollution control, air quality criteria, emission standards and regulations. (3 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, principles, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (5 q.h.)

771 Air Pollution - Sources of air pollutants, properties of small particles, chemistry of air pollution, dispersion and deposition of air pollutants, and air pollution control. (3 q.h.)

Civil Engineering:

516 Water Resources Engineering - Pipe systems, introduction to open channel flow, basic hydrology, demographic studies, water supply, and wastewater flows. (4 q.h.)

518 Environmental Quality - Introduction to environmental quality; air pollution; solid waste disposal; water quality and treatment; wastewater characteristics and treatment. (4 q.h.)

521 Water Distribution and Wastewater Collection - Design of water supply collection, transmission and distribution systems; design of sewage and storm water collection and disposal systems. (3 q.h.)

603 Remote Sensing of Environment - The energies of the natural and cultural environment; current remote sensing systems and case histories of applications in measuring the environment. (4 q.h.)

610 Analysis of Natural and Polluted Waters - A laboratory study of the measurement and interpretation of water quality indices and pollution, parameters including BOD, COD, alkalinity, nutrients, pH, and heavy metals. (4 q.h.)

613 Applied Hydrology - Hydrologic cycle, meteorology, streamflow, evapotranspiration, hydrographs, runoff relations, runoff

613 (Cont'd) - hydrographs, groundwater, unit hydrographs, flood routing, frequency and duration studies, and application of hydrologic techniques. (4 q.h.)

618 Design of Treatment Facilities - Selection and design of processes for the purification of drinking water and the treatment of wastewaters. (4 q.h.)

677 Noise, Pollution and Safety Aspects of Transportation Systems - Vehicle noise and emissions as affected by operating characteristics; noise measurement and abatement techniques; air quality legislation, air pollution; traffic accident analysis. (4 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, principles, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (5 q.h.)

715 Water Resource Systems: Water Quantity - Planning, design, and operation of reservoirs for single and multiple-purpose use, flood estimation and management alternatives, conjunctive use of ground and surface water. (4 q.h.)

717 Industrial and Municipal Solid Waste Disposal - Characterization and sources of solid wastes; solid waste management; collection systems; processing; disposal; and recycle. (3 q.h.)

719 Stream Sanitation - A study of stream quality standards; effluent standards; and the assimilative capacity of natural water bodies. (4 q.h.)

720 Water Resource Systems: Water Quality - Mathematical modeling of conservative and non-conservative pollutants in aquifers, streams, lakes, estuaries and coastal waters and methods for obtaining least cost correction measures. (4 q.h.)

724 Dynamic Oceanography - Physical and chemical properties of pure and sea water; global energy balance, governing equations, ocean statics, circulation features, stratification, chloride and pollutant distribution; tide prediction and measurement. (4 q.h.)

810 Physical Water and Wastewater Treatment Processes - Principles and design of physical processes for water and wastewater treatment including screening, sedimentation, mixing, flotation, and filtration. (3 q.h.)

811 Biological Wastewater Treatment Processes - Principles and design of biological processes for wastewater treatment. (5 q.h.)

812 Chemical and Advanced Wastewater Treatment Processes - Principles of physical-chemical treatment processes for water and wastewater, including coagulation, softening, absorption, nutrient removal and disinfection. (5 q.h.)

814 Industrial Wastewater Treatment - Principles of industrial wastewater treatment including wastewater surveys; flow reduction, and segregation and equalization; batch and continuous treatment; instrumentation; and treatment processes. (3 q.h.)

Economics:

591 Economics of Environmental Quality - Economic analysis of the relationships among natural resources, growth, pollution control, congestion, and social institutions. (5 q.h.)

Entomology:

532 Pesticide Regulations - Study and discussion of Ohio and U.S. pesticide regulations; rationale of the regulations will be correlated with the biological and environmental effects of pesticides. (2 q.h.)

641 Insect Ecology - The distribution, abundance, population regulation, plant-insect interactions, and species survival patterns of insects are analyzed in relation to microenvironment and ecosystems. (5 q.h.)

660 Advanced Economic Entomology - Theory and practice of pest population management, emphasizing current research and field studies involving practical experience with insect control. (5 q.h.)

662 Principles of Insect Toxicology - The properties of insecticides, modes of action, metabolism, toxicity factors, joint action, resistance, experimental procedures and interpretation of data. (5 q.h.)

841 Biological Control - Reports and discussions on the predators, parasitoids and microbial pathogens affecting plants and invertebrates, particularly insects. (5 q.h.)

Mechanical Engineering:

640 Principles of Environmental Control - A study of the principles of the control of environments for human occupation, occupation by other living beings, the operations of mechanical and electrical equipment, and for the storage and processing of materials. (3 q.h.)

841 Advanced Environmental Control - An advanced study of conventional and unique systems used to control the environment for occupancy by people, equipment, and material. (3 q.h.)

842 Advanced Environmental Control Problems - A study of methods of synthesis and analysis pertaining to the creative design of environmental control systems, involving conferences and theoretical and/or experimental investigations. (1-18 q.h.)

INSTITUTION: OHIO UNIVERSITY

PROGRAM: Environmental Studies

DEPARTMENT: Interdepartmental

DEGREE: Master of Science in Environmental Studies
(For undergraduate degrees available, see addendum.)

CONTACT: Dr. John R. Collier, Associate Dean
Graduate College
Graduate Building
Ohio University
Athens, Ohio 45701
(614) 594-5824

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Established in 1973, the master's degree program in Environmental Studies at Ohio University seeks to prepare students in handling our environmental problems. This interdepartmental program consists of a series of core courses required of all students and two available areas of concentration - the biological sciences (botany, and microbiology and zoology) and the physical sciences (chemical engineering, chemistry, civil engineering, geography, geology, industrial and systems engineering, and mechanical engineering). Students completing this program may enter teaching, government, or business and industry.

The Environmental Studies program is administered by a steering committee with seven members representing participating departments. While courses are generated basically within individual departments, the steering group oversees curriculum matters and operating procedures.

Research facilities are located within individual departments; but students have access to a wide range of scientific equipment including an IBM 370/158 computer, two transmission microscopes and one scanning electron microscope, NMR, EST, automatic X-ray, and I.R. Fourier Transform. Faculty members within the Environmental Studies program have received a number of research grants: a $100,000 National Science Foundation project; a bioethics grant from NEH; demographic grants from the Department of Health, Education, and Welfare and the Department of Housing and Urban Development; a Rockefeller grant to study the impact of over-population on land use and resources; monies for acid-mine research; and state funding for a study of the effects of clear cutting.

Through individual faculty members, the Environmental Studies program is also involved in extension and outreach projects. One staff member periodically conducts environmental education workshops for teachers. Another faculty member has direct responsibility for a summer course in hydrology and water resource evaluation geared to professionals and persons preparing for careers in hydrology; the course has won praise from participants nationally and internationally. Other summer course offerings are designed for school teachers who usually can only attend the university during that term.

PROGRAM REQUIREMENTS

Applicants to the Environmental Studies program must hold baccalaureate degrees in the natural sciences or in engineering, or have equivalent backgrounds in other fields. Degree requirements specify that candidates take at least ten credits in the core courses and a minimum of 16 additional credits in an area of concentration. Both thesis and non-thesis options require at least 48 credit hours. With the thesis, students have nine credits in thesis research and twelve credits in other graduate courses specified by each individual student's advisory committee. If students select the non-thesis degree, they must complete 21 credits in other graduate courses specified by their advisory committees, including three or more credits in a research-oriented course, such as Special Investigations. The required core courses are Animal Ecology or Population Biology, Geographic Perspectives on Resource Management and Conservation, and Environmental Law. If there are deficiencies in one's preparation that would impede graduate work, he or she must take additional transition courses.

CURRENT FACULTY, STUDENTS, GRADUATES

There are no faculty members specifically assigned to the Environmental Studies program; however, nearly 50 faculty from 13 departments are involved through course offerings, service on student advisory committees, and the Steering Committee. There are presently eight full-time and two part-time students enrolled in the program; they represent a heterogeneous blend on disciplines--law, education, geography, sciences, and more. Some are "career-change" students or teachers desiring retraining while others choose the program out of sheer interest in what it has to offer. Students are administratively lodged in individual departments, but they are subject to this program's requirements rather than their own department's requirements.

Approximately 50 percent of the graduates are placed in government positions upon graduation while the remaining 50 percent usually enter or return to teaching. Few if any students pursue additional degrees nor would they necessarily be advised to do so; this master's degree program is essentially a generalist and terminal degree. The program confers roughly 5-10 diplomas annually.

Financial aid to students includes scholarships, tuition-waivers, and teaching and research assistantships within individual departments. A limited number of students engage in field work through faculty grants.

PROGRAM PROJECTIONS

With financial support, the Environmental Studies program at Ohio University could consider giving some faculty members direct responsibilities in the program, even on a part-time basis, in order that more specific environmental courses could be developed. The possibility of offering an environmental education certificate is under consideration though still very much on the drawing board. The stable enrollment in the program is encouraging; but the faculty are very concerned about the job-market situation, especially the lack of employer awareness concerning the scope of skills Environmental Studies graduates can offer. Placement is not a problem now, but it is difficult to obtain information on where jobs are. There exists a consensus among the faculty involved in this program that training monies are needed and that environmental training and problem-solving should be focused at the university level where all aspects of the environment can be studied--technical, economic, and social.

COURSE DESCRIPTION

Core Courses:

Business Law 570 Environmental Law - Legal aspects of individual and societal environmental rights and duties with respect to U.S. Constitution, private property, nuisance, negligence, statutes, court decisions, and rulings affecting policy decisions. (4 q.h.)

Geography 527 Geographic Perspectives on Resource Management and Conservation - Problems in management of renewable natural resources approached from geographic and ecologic viewpoints. (5 q.h.)

Zoology 575 Animal Ecology - Relation of animals to their habitat, to each other, and to man. General principles of terrestrial and aquatic communities, ecosystems, and man's involvement. (3 q.h.)

Zoology 577 Population Biology - Quantitatives aspects of genetics and ecology of plant and animal populations; emphasis on conceptual framework and its application to natural populations. (4 q.h.)

Environmental-Related Courses:

Anthropology 578 Cultural Ecology - Analysis of mutual and reciprocal relations between socio-cultural systems and other systems in their environment; ecosystems and biotic communities in which human populations are included. (5 q.h.)

Botany 625 Plant Ecology - Environmental factor effects on species growth and distribution; review of recent ecological literature. (5 q.h.)

Botany 626 Vegetation Analysis - Analysis of natural plant communities and readings in literature of community ecology. (5 q.h.)

Botany 654 Phycology - Classification, nomenclature, relationships, morphology, reproduction, life histories, and economic importance of fresh-water and marine algae. (5 q.h.)

Botany 754 Experimental Ecology - Theory and methods involved in studying natural plant communities. (5 q.h.)

Botany 757 Topics in Plant Ecology - Theories and principles of plant distribution as related to evolution, migration and speciation of plants. (5 q.h.)

Business Administration 565 Technology and the Environment - There is everywhere a great concern for things to come. Real problem is not just to predict the future but how to anticipate, control and change it. Course is conceptual, future-oriented, and interdisciplinary. Variety of developmental problems and interaction of many technological environments including social, political, economic, marketing, as well as technical. (4 q.h.)

Engineering, Chemical 560 Atmospheric Pollution Control - Air pollution from major industries, internal combustion engines, and other sources. Techniques available for measuring particulate and gaseous pollutants in atmosphere and at their sources. Techniques available for control and future possibilities for control of air pollution. Bases for air pollution legislation. (4-5 q.h.)

Chemistry 579 Radiochemistry - Application of radiation and radioactive isotopes to problems in chemistry and environmental sciences; detection and determination of radiation; safe handling and disposal of radioactive materials and other problems in environmental radiation safety. (4 q.h.)

Civil Engineering 555 Advanced Water Treatment - Advanced study of theory. Design of treatment units. Practice in control methods. (4 q.h.)

Civil Engineering 556 Advanced Waste Water Treatment - Advanced study of theory. Design of treatment units. Practice in control methods. (4 q.h.)

Civil Engineering 558 Water Quality Engineering - Natural and man-made characteristics of water quality, changes in quality resulting from use, criteria for control of stream pollution, methods of improving water quality, legal and economic aspects.

Geography 512 Climate - Exchanges of energy and moisture and their significance in man's utilization of earth's surface. (5 q.h.)

Geography 622 Population Geography - Systematic survey of world population problems including distribution, composition, fertility, mortality, density, age-sex structure, and impact of these on world population growth and resources. (5 q.h.)

Geography 629 Settlement Geography - Patterns and forms of rural settlement in terms of environmental, functional, and traditional effects. (5 q.h.)

Geography 630 Advanced Urban Geography - Such selected topics as internal structure, urban physical environment, and others. (5 q.h.)

Geology 503 Geological Aspects of Environmental Science - Overview of role of geological data in problems concerning mineral and fuel resources, land uses, natural hazards, and pollution of our environment.

Geology 680 Hydrogeology - Principles governing occurrence, movement, and recovery of water in soil and aquifers, water budget, water pollution, water chemistry. (4 q.h.)

Geology 683 Field Hydrology - Field training in techniques of hydrology and water resources evaluation. (6 q.h.)

Industrial and Systems Engineering 567 Environmental Systems Engineering - Overview, analysis, and design of selected environmental systems. Problems selected from area of conversion, resource engineering, communication, bioengineering, transportation, pollution, engineering of large structures, and engineering of community systems. (3 q.h.)

Mechanical Engineering 570 Energy and the Environment - Examination of ramifications of energy in contemporary society. Basic energy concepts; technical considerations of production of energy; conservation strategies; environmental and economic considerations; emerging energy technologies including nuclear, fusion, solar and wind power. Course designed to prepare individual for effective participation in societal actions related to energy and power. (3 q.h.)

Microbiology 511 General Microbiology - Properties of microorganisms and their importance in our environment. Laboratory training in common microbiological methods. (6 q.h.)

Microbiology 512 Microbiological Techniques - Semi-independent course gives microbiology majors extensive experience in use of bacteriological techniques and equipment; information retrieval. (4 q.h.)

Microbiology 518 Epidemiology - Model of spread, cure, and prevention of communicable diseases in humans. (4 q.h.)

Zoology 530 Invertebrate Zoology - Structure, function, systematic, and ecological relationships among full range of phyla. (6 q.h.)

Zoology 537 Medical Entomology - Relationship of insects and related arthropids to human disease. (4 q.h.)

Zoology 560 Animal Physiology - General and comparative physiology emphasizing principal functions underlying life processes. Emphases on physiological adaptations to environment and neurophysiological systems. (4 q.h.)

Zoology 576 Ecology Laboratory - Field course for animal ecology, consisting of visits to and studies of various local terrestrial and aquatic communities. (2 q.h.)

Zoology 779 Experimental Animal Ecology - Research methods in ecology with emphasis on collecting, quantifying, and portraying data obtained during course; population density, dispersion, dynamics, and interactions; community productivity, metabolism, and succession. (6 q.h.)

INSTITUTION: OSCAR ROSE JUNIOR COLLEGE

PROGRAM: Environmental Science

DEPARTMENT: Environmental Science

DEGREE: Associate of Applied Science (A.A.S.) in Environmental Science

CONTACT: Mr. Harold Fox
Director, Environmental Science
Oscar Rose Junior College
6420 S.E. 15th Street
Midwest City, Oklahoma 73110
(405) 737-6611 x 247

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Associate of Applied Science degree in environmental science is one of 54 degrees offered by Oscar Rose Junior College. Environmental science is a new program at Oscar Rose, which was organized in 1976.

The environmental science degree program emphasis is on preparation of students for a variety of occupations in the fields of pollution control and abatement. The course work offers study in the areas of air, water, wastewater and noise, as well as pest and vector control. Upon completion of this program the graduates are considered to have received sufficient training as generalists to be able to enter the world of work or continue their education. Indicative of the occupations which these students may enter, are: vector control specialists; regulatory specialists; solid waste systems manager; sanitary technician; and engineering aide.

PROGRAM REQUIREMENTS

Students are eligible for enrollment in the environmental science program pursuant to acceptance by the college. There are no special requirements for admission to this program.

Requirements for the two year Associate of Applied Science degree in environmental science include successful completion of the following: 1) general education requirements: 17 semester hours in English, histroy, political science, psychology and physical education; 2) science requirements: 22-24 semester hours in life sciences, chemistry and introductory environmental science; 3) special areas requirements: 23-28 semester hours which include the following courses: ENSC 1113, 2123, 2190, 2223 and 2233; LFSC 2215 and 2225; 4) mathematics requirements: 3 semester hours.

CURRENT FACULTY, STUDENTS, GRADUATES

The teaching and administrative faculty of the environmental science program include three full-time personnel. All three are cost-centered. In addition there are six to seven supplemental part-time faculty which contribute efforts to this program.

Enrollment totals 16 students. There are six male and two female full-time, and seven male and one female part-time students. The average student enrolled in this program is approximately 28 years old. Upward mobility is a major factor which encourages the students to reenter school. The program, however, also attracts career change students.

The first students of this program were granted the associate degree in 1977. The total number of graduates in the first year was three. All of these graduates are pursuing the baccalaureate degree. The institutions receiving these students as transfer were the University of Oklahoma at Norman, and East Central Oklahoma State University at Ada.

PROGRAM PROJECTIONS

Although significant faculty increases or decreases will probably not occur in the near future, there is every indication that this program will experience at least a 10% per annum growth over the next few years.

Two new courses are under development for this program. One course will emphasize occupational health and safety. The other will be a course related to hazardous materials. No time-lines have been established, as yet, for this proposal.

COURSE DESCRIPTION

ENSC 1101 Orientation to Environmental Science - An introduction to the field of environmental science by exploring the opportunities, advantages, and requirements of the profession. (1 s.h.)

ENSC 1103 Introduction to Environmental Science - A cursory survey of man's misuse of the environment; examination of possible control measure for pollution of resources of air, land, water and food. (3 s.h.)

ENSC 1113 Environmental Ecology - An examination of man and his environment through discussion and observations of cultural and social impacts. (3 s.h.)

ENSC 2213 Wastewater Plant Equipment II - Theory of operation and maintenance of electrical, electronic, pneumatic control systems and other electromechanical equipment found in wastewater treatment facilities. (2 s.h.)

INSTITUTION: OSU OKLAHOMA CITY TECHNICAL INSTITUTE

PROGRAM: Environmental Health

DEPARTMENT: Civil Technology

DEGREE: Associate of Science (A.S.) in Civil Technology

CONTACT:
Mr. Garland C. Pendergras
Director, Civil Technology
OSU Oklahoma City Technical Institute
900 North Portland
Oklahoma City, Oklahoma 73107
(405) 272-0533

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The OSU Oklahoma City Technical Institute is an institution charged with the responsibility of training for employment in various career fields. The Institute may be described as quasi-independent of the Oklahoma State University. Located in central Oklahoma City, the Institute offers two-year career oriented training programs which may lead to the Associate of Science degree. Educational methods emphasize applied procedures. In response to the needs of the students, the theoretical approach to teaching and learning is stressed to a lesser degree. The majority of the students are employed full-time and thus the accomplishment of the Associate of Science degree usually requires a prolonged time period, in excess of the two years normally allocated to associate level studies by full-time students.

The Institute addresses the needs of a targeted population which includes Oklahoma City residents almost exclusively. The Institute is rather strategically located within the city in order to meet the student occupational training and academically related needs. Students are prepared to enter the world of work at the technician level. At the same time, the credits are transferable to baccalaureate programs.

The Associate of Science environmental health concentration is one of at least 14 two-year career preparation programs offered by the Institute. This particular program has been available through the Institute since 1971.

PROGRAM REQUIREMENTS

Achievement of the Associate of Science degree requires successful completion of at least 68 credit hours. The curriculum is arranged so that at least 10 hours are common requirements for all students. In addition, 10 credit hours of mathematics are requirements in common for all engineering technology students. The environmental health curriculum places particular emphasis on the areas of air and water resources. To be eligible for the associate degree, students must maintain an overall grade average of "C" or better in all courses applicable to the degree.

The program does not require a minor. Major area course requirements include 26 credits in civil technology courses which include the following: CIVT 1102, 1212, 1232, 2123, 2133, 2343, 2643, 2704 and 2753.

CURRENT FACULTY, STUDENTS, GRADUATES

The current faculty allocated to the environmental health program includes one part-time and two full-time instructors. Two of these faculty members are cost-centered.

Student enrollment in this program includes 20 part-time registrants. The average student in this program is approximately 30 years old. Very few students are considered as full-time. Of the 2,300 total students at the Institute, approximately 30% may be classified as full-time. The current complement for this program consists of 85% male and 15% female students.

The average number of graduates from this program is two or three per annum. Historically, students pursue this program from four to six years in order to complete the Associate of Science degree requirements. This extended time-frame is attributed to the fact that most of the students are employed full-time, thus precluding enrollment in the normal complement of courses. A number of students, upon completion of the occupationally oriented courses, encounter problems (either real or imagined) which curtail their continuation of the academic requirements. The Institute meets this challenge by offering remedial level English and math. Although these are no-credit courses, often they enable the students to up-grade in areas in which they were previously deficient.

Approximately 30% of the students elect to pursue the baccalaureate upon completion of the Associate of Science degree.

Federal, state and local monies assist in the area of student tuition support, to a limited degree.

PROGRAM PROJECTIONS

Future planning at the Institute emphasizes expansion of this program pursuant to the needs of the population served. Faculty anticipate an approximate 5% per annum growth rate for this program.

COURSE DESCRIPTION

CIVT 1012 Introduction to Public Works - A survey course designed to expose the beginning student to the organization, function and

CIVT 1012 (cont'd) - administration of public works; including utilities, streets and drainage, permits and inspection, traffic control, water supply, and pollution control.

CIVT 1102 Introduction to Environmental Health Technology - This course is designed to give the student an introduction to the environmental problems in the ecological/technological system. A general progression of the history of the world environmental problems with a prospectus for the future. Basic laboratory and field techniques for environmental studies will be undertaken by the students. (3 s.h.)

CIVT 1113 Traffic Control and Safety Devices - Traffic control devices, methods and planning, signalization, signing, channelization and lighting.

CIVT 1123 Materials of Construction - A study of the properties and use of materials relative to the construction of roadways, dams and bridge-type structures, including testing of soils, asphalt and concrete. (3 s.h.)

CIVT 1213 Air Quality Control Technology - Study of the causes, effects and control of air pollution, how individuals, communities, metropolitan areas, and industry can prevent pollution. Students will conduct atmospheric sampling and laboratory analysis studies. A large proportion of this course will be directed toward laboratory procedures. (3 s.h.)

CIVT 1232 Principles of Hydraulics - Principles of fluid mechanics, pressure conduits, open channel flow, fluid measurement, drainage structures, design of collection systems for municipal drainage. (2 s.h.)

CIVT 2103 Highway Design and Construction - Study of transportation roadways and their functions. Roadway foundations; pavement types, characteristics, composition and structural design; construction procedures; transportation systems planning.

CIVT 2113 Urban Transportation Systems - Special problems of the metropolitan transportation systems are considered including economics, financing, planning, right-of-way, and projecting future developments.

CIVT 2123 Solid Wastes Disposal - Devices, techniques and procedures for solid wastes collection and disposal; theory of combustion and incinerator design; solid waste management. (3 s.h.)

CIVT 2133 Industrial Hygiene Technology - Practices and procedures concerning industrial hygiene and safety; review of state and federal laws; evaluation and control of occupational environmental hazards including dust, noxious gases, abnormal temperature and pressure, noise control, and lighting. Extensive laboratory work will be conducted at on-site locations with local industry. (3 s.h.)

CIVT 2143 Water Bacteriology - The role of bacteria, molds and other microorganisms in relation to community health and sanitation, in

CIVT 2143 (cont'd) - water supply treatment and in waste forms. Laboratory exercises stress modern techniques of bacterial identification and procedures necessary to assure the bacteriological safety of water. (3 s.h.)

CIVT 2232 Route Surveying - Principles of route surveys, use of photogrammetry in route design and layout. Computer applications. (3 s.h.)

CIVT 2313 Strength of Materials - Study of forces, stress and strain and their effects on materials; analysis of trusses, torsion and couples. (3 s.h.)

CIVT 2323 Inspection Principles - A practical course especially designed to acquaint the student with the importance of the inspector's job, the basic field procedures and modern methods of testing compliance with specifications. (3 s.h.)

CIVT 2343 Environmental Control Instrumentation - Application of mechanical and electrical control systems needed in air and water sampling and testing devices and their performance characteristics, accuracy and application. Laboratory work related to operations, maintenance and reliability studies of instrumentation will be included. (3 s.h.)

CIVT 2423 Advanced Surveying and Photogrammetry - Care and adjustment of instruments, controls by triangulation, photographic methods of mapping including ground control in aerial surveys, measurement and computation of earthwork, topographic surveys with conventional instruments and photographic methods. Oklahoma laws governing land surveys and professional licensing. (3 s.h.)

CIVT 2543 Transportation and Traffic Analysis - Conducting transportation and traffic analysis surveys and studies; their applications to capacities and planning.

CIVT 2633 Codes, Contracts and Specifications - Since the civil technician may be responsible for field inspection, it is necessary for him to be familiar with how specifications and related documents are written and used in the construction industry.

CIVT 2643 Water Resources and Treatment Processes - Water and its impurities; dams and reservoirs; underground and surface supplies, water for industrial use, water and waste treatment plant maintenance, operation and safety, industrial wastes, swimming pools, water quality standards.

CIVT 2704 Environmental Sanitation - Problems of general sanitation including water supply, domestic and industrial waste disposal, vector control, epidemiological studies, pesticides and chemical pollutants, food sanitation, recreation camps and swimming pool sanitation, sanitation inspection principles. (3 s.h.)

CIVT 2753 Concepts in Ecology - Study of biological interrelationships in the cycle of life: population dynamics, ecosystems, energy flow, and impact of pollution of the environment. (3 s.h.)

INSTITUTION: POLYTECHNIC INSTITUTE OF NEW YORK

PROGRAM: Environmental Engineering and Planning

DEPARTMENT: Civil and Environmental Engineering

DEGREE: Master of Science in Civil Engineering (M.S.C.E.)
Master of Environmental Health Sciences (M.E.H.S.)
Engineer
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Henry F. Soehngen
Chairman, Department of Civil and Environmental Engineering
Polytechnic Institute of New York
333 Jay Street
Brooklyn, New York 11201
(212) 643-2322

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental Engineering and Planning is one of six specializations offered by the Department of Civil and Environmental Engineering. This program developed from the Civil Engineering curriculum in the 1940s. About ten years later a program in Environmental Health Sciences was added.

Four separate concentrations are offered within this specialization: water quality engineering, air resources engineering, environmental health science, and environmental planning. Generally, a student will plan his course of study within any one of these areas. In the environmental health sciences concentration a student can receive the M.E.H.S. or the Ph.D. in Environmental Health Sciences, but not the Engineer degree. All other concentrations award the degrees of M.S.C.E., Engineer, or Ph.D. in Civil Engineering.

Program support is provided by the laboratory facilities of the Civil and Environmental Engineering Department and the Institute's Center for Urban and Environmental Studies, which initiates and coordinates programs of research and instruction in areas such as air and water pollution control, water resources, and solid waste disposal.

PROGRAM REQUIREMENTS

Admission to any of the graduate programs requires a bachelors degree from an acceptable institution and scores from the Graduate Record Exam. For the M.S.C.E. degree, a bachelor's degree in civil engineering is required. The M.E.H.S. program generally requires an undergraduate degree in science, although applicants with degrees in other fields may also be admitted. A master's degree in civil engineering is normally the requirement for entry into the Engineer or Ph.D. programs. A student may, however, be admitted to the Ph.D. program in environmental health science with a Master's degree in science.

Either Master's degree offered requires a minimum of thirty-six units of credit. This includes both prescribed courses and electives. A thesis or a project may be substituted for elective courses. The Engineer degree requires at least thirty-six units of work beyond the Master's level and includes a twelve unit design project. Requirements for the Ph.D. include a minimum of sixty-six units of academic credit, of which at least twenty-seven must be formal course work and thirty must be dissertation research. The Ph.D. program generally consists of one major field of concentration plus the minor fields. A dissertation and reading knowledge of one modern foreign language are also required.

CURRENT FACULTY, STUDENTS, GRADUATES

Faculty for the program consists of twelve full-time members. Most time is devoted to teaching, although about one-sixth of the faculty member's time is spent on research. Research funding is available from the New York State Energy Office and the National Science Foundation. At one time the program did receive EPA training grants.

There are currently two full-time and fifteen part-time students in the environmental health sciences programs and twelve full-time and one-hundred and fifteen part-time students in the environmental engineering programs. Students in these programs generally come from either the New York City metropolitan area or from foreign countries. Approximately fifty percent of the students are foreign, Recruitment of students is generally achieved through informal contacts of faculty and alumni. The distribution of brochures to employers and advertising in newspapers are other means of recruitment. Principal forms of student financial assistance include research assistantships, teaching fellowships, and tuition payment by employers.

Environmental health sciences graduate about five students per year and the environmental engineering programs graduate approximately seventy-two students each year. Both figures are indicative of a downward trend in enrollment. Most graduates go directly into employment with private industry and government agencies. Since most students are working while they are in the program, placement of graduates is not considered to be a problem.

PROGRAM PROJECTIONS

Program officials anticipate the addition of more courses to the program and expansion of research acitvities in water quality. This would probably require the addition of two faculty members. No estimate is available on when these changes may occur.

COURSE DESCRIPTION

(the following is a partial listing of courses)

CE 738 Sanitary Chemistry - Review and application of principles of chemistry to waters and wastewaters. Laboratory. (3 s.h.)

CE 740 Sanitary Microbiology - Microbiology of wastewater treatment processes, wastewaters, receiving waters. (3 s.h.)

CE 742 Water and Wastewater Treatment I - Study of physical, chemical, and biological principles involved in process design and treatment of water and wastewater. (3 s.h.)

CE 747 Analysis of Stream and Estuary Pollution - Analysis of dispersal and decay of contaminants introduced into lakes, streams, estuaries, oceans. Effects of pollutant on chemical quality and ecology of receiving waters. (3 s.h.)

CE 751 Environmental Health Engineering - Theory, methodology, and instrumentation associated with environmental health. (3 s.h.)

CE 752 Air Pollution - Study of the causes and effects of air pollution. Methods of sampling. Methods of air pollution control. (3 s.h.)

CE 753 Dispersion of Pollutants - Introduction to theory of diffusion of pollutants and methods for estimation of dispersion in atmosphere. Dispersion of pollutants in sea, lakes, rivers. Other topics. (3 s.h.)

CE 755 Air Pollution Chemistry - Significant chemical reactions occurring in lower atmosphere and basic chemistry required to understand problems peculiar to air pollution field. (3 s.h.)

CE 758 Air Pollutant Engineering Control - Fundamentals of adsorptive, absorptive, and reactive recovery and control; removal of gaseous oxides of nitrogen, carbon, and sulfur; removal of particulates from moving and stationary sources; other topics. (3 s.h.)

CE 760 Planning and Engineering of Urban Environmental Systems I - Consideration of sociological, political, and economic values in planning and engineering of urban communities. (3 s.h.)

CE 770 Solid Waste Management - Engineering aspects of solid waste collection, transport and disposal, including incineration, sanitary landfill, composting, recovery and reutilization, economic evaluation of factors affecting selection of disposal methods. (3 s.h.)

INSTITUTION: PURDUE UNIVERSITY

PROGRAM: Environmental Sciences Option

DEPARTMENT: School of Science

DEGREE: Bachelor of Science

CONTACT: Dr. James Yackel, Associate Dean, School of Science
Purdue University
Mathematical Sciences Building
West Layfayette, Indiana 47907
(317) 494-8500

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The program began in 1973 and more than 70 courses are offered. It is interdisciplinary within the School of Science, although course work from many departments is accepted towards the environmental science option.

Options open to students include, but are not limited to: general environmental studies, air pollution, water pollution.

General environmental studies can be agriculturally oriented or science and engineering oriented. A minor in air pollution might be combined with a major in atmospheric sciences. A minor in water pollution might be combined with chemistry and geosciences. Each program is tailored to the student's professional orientation with the help of a faculty member or academic adviser.

PROGRAM REQUIREMENTS

Freshman admission requirements to the School of Science are:

1) high school graduate with 16 units: English (6), History or Social Studies (2), Algebra (3), Geometry (2), Trigonometry (1), Laboratory Science (2);
2) Indiana residents must be from the upper half of their high school graduating class and have SAT scores in the upper half of national norms;

   Out-of-state must be in the upper third of their high school graduating class and have SAT scores in the upper third of national norms;

3) SAT scores and College Entrance Examination Board achievement tests in English, Mathematics, Chemistry (used for academic placement);

4) information provided by high school counselor.

A B.S. in the General Science program requires 124 credit hours:

general scientific studies	35 - 40 hours
major science concentration	12 - 23 hours
additional scientific studies	4 - 10 hours
minor concentration	18 hours
general humanistic studies	27 - 28 hours
free electives	5 - 28 hours

In preparation for the environmental science minor, Ecology: BIOL 585-586, Programming I: CS 220, Experimental Statistics I: STAT 501, and one or more of 11 specified courses from Economics, Political Science or Sociology should be taken.

CURRENT FACULTY, STUDENTS, GRADUATES

There is no special faculty for the environmental studies options. Courses are offered through the regular academic departments of the School of Science and the faculty there numbers 280. Research has been done with Lake Michigan shore erosions, northern Indiana dunes, population ecology and field ecology.

Presently there are 15 enrolled in the program; 4 graduate yearly. Fifty percent of the students receive employment in government 25 percent in industry and 25 percent in other areas.

About 200 undergraduate students are assisted financially through teaching assistantships, research assistantships or an hourly wage. A co-operative program is also available. Students complete two years of school and then, while working on campus or during the summer, take four credit hours a semester. Obtaining a degree in this manner takes four and one-half years. In the past, arrangements have been made with government labs (i.e., Argonne) to provide these opportunities.

PROGRAM PROJECTIONS

The department sees no change in the long range goals and objectives of the program. The various options are seen as continuing to be chosen by a small number of students. The impetus for change will need to come from a small nucleus of faculty.

ADDITIONAL INFORMATION

The School of Science has four departmental libraries: Chemistry, Geosciences, Mathematical Sciences, and Physics. The Department of Biological Sciences is served by the Life Science Library.

COURSE DESCRIPTION (a partial listing; others available from agriculture, entomology forestry, horticulture, civil, mechanical, electrical engineering)

Undergraduate:

Bio. Sciences: 285 Environmental Biology - Interactions of the biotic and abiotic components of natural environments. Ecological principles and phenomena associated with populations, communities, and ecosystems. Natural selection and other aspects of evolution. Principles of conservation. (3 s.h.)

Computer Sciences: 220 Programming I - Introduction to the intuitive notion of an algorithm; representation of algorithms in narrative form as flow charts and as computer programs; general structure of computers; computer experience using a procedure-oriented language in programming algorithms such as those used in elementary numerical calculations, sorting, simulation of a random process and symbol manipulation; definition and use of functions, subroutines and iterative procedures; survey of a variety of significant uses of computers. (3 s.h.)

Physics: 200 Our Physical Environment - Selected topics in physics which relate to man's environment. Particular emphasis will be placed on energy resources, relationships between medicine and physics, and modern applications of discoveries in physics. (3 s.h.)

Undergraduate/Graduate courses:

Atmospheric Sciences: 539 Air Pollution Meteorology - Sources of air pollution and variations of pollutants with space and time. Concepts of hydrostatic stability and turbulent flow in the atmospheric boundary layer, with application to urban diffusion models. Requirements and limitations of air pollution measurements, a total monitoring program and analysis of data. The role of macroscale circulation systems and large scale weather prediction in air pollution potential forecasting. Principles of radiation transfer and cloud physics applicable to potential climate modification by air pollutants. (3 s.h.)

Biological Sciences: 585 Ecology - Examination of ecological principles derived from study of patterns of distribution and abundance in plants and animals; structure and function in populations, communities, and ecosystems; role of population genetics, adaptation, and evolutionary theory in ecology. (2 s.h.)

586 Laboratory in Ecology - Laboratory and field studies designed to demonstrate ecological principles; sampling

586 (Cont'd) - methods and problems of experimental design; application of selected statistical methods in the analysis and interpretation of data; simulation models in population genetics, population ecology and ecosystem function. (2 s.h.)

Statistics: 501 Experimental Statistics I - Fundamental concepts and methods of statistics for students interested in the analysis of experimental data. Subjects include descriptive statistics, basic probability theory, normal distribution, tests of hypotheses and confidence intervals for normal and Bernoulli populations, contingency tables, tests of goodness-of-fit; linear regression and nonparametric tests. (3 s.h.)

INSTITUTION: RAYMOND WALTERS GENERAL AND TECHNICAL COLLEGE OF THE UNIVERSITY OF CINCINNATI

PROGRAM: Environmental Control/Protection Technology

DEPARTMENT: Biology

DEGREE: Associate in Science

CONTACT: Dr. Judith M. Schultz, Director
Environmental Control/Protection Technology
Raymond Walters General and Technical College
University of Cincinnati
9555 Plainfield Road
Cincinnati, Ohio 45236
(513) 745-4200

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

An admission requirement to the Environmental Control/Protection Technology program at Raymond Walters is "an interest in combating pollution." To this end, students pursue Associate in Science degrees preparing them for "work as technical assistants to environmental biologists, chemists, engineers, and physicists" or employment in "government and industry in the fields of air, water, and solid waste pollution control, and in related areas of environmental health." Training reflects the dual philosophy of the college: to graduate students with a general education who are at the same time adaptable, thinking technicians.

Budgetary considerations require the multidisciplinary Environmental Control/Protection Technology (EC/PT) program to be housed in the Department of Biology. Nonetheless, students can expect their coursework to involve "surveys of environmental issues and problems; air, water, and solid waste pollution control engineering; nationally approved water and air sampling and analysis techniques; biology, chemistry, and physics courses; communication skills; salaried internship with federal government or industry; and a well-rounded college program."

Research and support facilities are equipped for teaching a variety of techniques and instrumentation: BOD, COD, DO, and TOC tests, benthic diversity indices, fish, and plankton sampling; Standard Methods and E.P.A. approved water analyses; data collection and analysis; coliform and MPN analysis; atomic absorption; Ringelman tests; stack and ambient sampling; spectrophotometry; titration; dilution; gravimetric and volumetric analysis; instrument calibration; SO_2, NO_2, and O_3 analyses; and sewage digestion analysis. Students have access to a gas chromatograph, high volume sampler, Pitot tubes, turbidimeters, pH meters, and analytical balances. The program emphasizes a "hands-on," one-to-one relationship of student to equipment.

The College is essentially a teaching institution with no real research activities. Several faculty in the EC/PT program do publish in environmentally-related journals. One staff member, with Environmental Protection Agency funding, has developed an individualized training program in water treatment. The program director's interest in population research has resulted in publications, in-service courses for high school teachers, and contributions to ERIC (Educational Resources Information Center). An advisory committee composed of 26 individuals from local industry and consulting firms, the University of Cincinnati, and the nearby research units of the National Institute of Occupational Safety and Health and the U.S. Environmental Protection Agency provides curriculum oversight and training recommendations to improve the marketability of graduates.

The internship scheduled for the final quarter in the program sequence facilitates job placement as well as giving students a supervised, on-the-job training experience. To date, internships have been in industry (Proctor and Gamble, Formica Corporation, Snow Filtration, Hilton-Davis); government (Environmental Protection Agency, National Institute of Occupational Safety and Health); and environmental consulting firms in the area.

PROGRAM REQUIREMENTS

Applicants must be graduates of an accredited high school or have completed the GED and take either the ACT (minimum comp score of 19) or the SAT (minimum total of 875, verbal 400) and the Raymond Walters Placement test in mathematics. Students are encouraged to have had one or more sciences in high school. Those with poor academic records in high school are often placed in remedial programs giving them a long-range entrance into the EC/PT program and a chance for schooling. Students must complete a minimum of 103 quarter hours to attain the Associate in Science degree offered by this program.

CURRENT FACULTY, STUDENTS, GRADUATES

Seven faculty members (four full-time and three who teach modular sections) serve the seventeen full-time and eight part-time students currently enrolled in the EC/PT program. The curriculum very definitely attracts career-change students, especially baccaulaureate graduates in the physical, biological, and social sciences for whom graduate school is not an option and employment opportunities are limited. The program graduates approximately twelve to fifteen students annually. Job placement records indicate that roughly 16 percent enter industry, 16 percent enter consulting, and 66 percent enter government work.

Financial support is available in the form of scholarships and standard student loan and grant programs administered through the Student Affairs Office. Also, interns receive salaries based on their educational background and at level comparable to similarly-educated full-time employees in the firm or agency sponsoring their internship.

PROGRAM PROJECTIONS

The Environmental Control/Protection Technology program projects the implementation of occupational health courses in the summer session--classes primarily for persons already in the field. Decisions regarding integration of such course into the regular curriculum will depend largely on the results of a survey of area industry and business regarding their manpower needs for two-year technicians in this area. The dual emphasis on general education and diverse technical training produces graduates that are in demand in industry and consulting. The proximity of environmental agencies and firms and industries with environmental concerns fosters a student awareness of the growing numbers of jobs in this technical area. Enrollment figures indicate more people are taking coursework part-time while employed full-time. However, luring students into the field when they have little conception of what it offers or demands remains a problem in Cincinnati and nationwide.

COURSE DESCRIPTION

Environmental Control/Protection Technology:

241 Environmental Engineering I - Module 1: Introduction to air contaminants, and engineering approaches for source sampling, analysis and control. Module 2: Introduction to solid waste pollution and engineering control methods. (3 q.h.)

251 Environmental Engineering Lab - Laboratory corequisite to Environmental Engineering 241. Stack sampling, particulate analysis and visitation to solid waste pilot projects. (1 q.h.)

242 Environmental Engineering II - Module 1: Introduction to solid waste pollution and engineering control methods. Module 2: Introduction to wastewater pollutants and engineering approaches for sampling, analysis, and control. (3 q.h.)

252 Environmental Engineering Lab - Laboratory corequisite to Environmental Engineering 242. Visitation to solid waste pilot projects; water purification and sewage treatment analysis techniques. (1 q.h.)

275 Environmental Physics - A survey of selected topics including heat, sound, and radiation as related to environmental control and industrial health. (4 q.h.)

271 Environmental Field Internship - Cooperative internship opportunity with local industrial and governmental environmental management systems. (12 q.h.)

071 Environmental Career Orientation - Presentations by guest lecturers related to career opportunities, resume preparations and procedures for employment application, site visits to environmental control/protection facilities. (1 q.h.)

Biology:

141, 142 Man and Environment I, II - A discussion-lecture seminar series of selected topics dealing with problems of pollution, environmental management, and public and industrial health. Occasional guest presentations by experts in the community. (3 q.h. each qtr.)

272 Biological Water Sampling and Analysis - Field and laboratory sampling utilizing methods approved by Standard Methods/E.P.A. Plankton, benthic diversity indices, coliform and ichthyologic studies. BOD. (4 q.h.)

275 Contemporary Ecological Problems - Seminar on current environmental issues, and their historical, biosocial, and ethical implications. Presentation of classical and contemporary case studies. (3 q.h.)

Chemistry:

281 Chemical Air Analysis Lecture - Sampling and analysis of current air pollution parameters by classical and instrumental methods. (3 q.h.)

291 Chemical Air Analysis Laboratory - Experimental work supplementary to 291. Application of gas laws to air movers and air measuring instruments; calibration, operation of such instruments as air sampling units, UV, visible, and atomic absorption spectrophotometers, and gas chromatographs; performing laboratory analysis for SO/2, NO/2, O/3, metals, particulates, and aldehydes. (1 q.h.)

282 Chemical Water Analysis Lecture - Sampling and analysis of current chemical parameters of water quality by classical and instrumental methods. Familiarization with federal water quality standards and acceptable methodologies for various water quality parameters including alkalinity, acidity, hardness, fluoride, sulfate, nitrogen, mercury, phosphate and solids. (2 q.h.)

292 Chemical Water Analysis Laboratory - Experimental work supplementary to 282. Development of basic laboratory techniques including electrometric titration, colorimetric techniques, and assembling a distillation apparatus. Use of basic laboratory equipment such as a pH meter, spectrophotometer, and Coleman Mercury Analyzer. Exposure to atomic absorption and chromatographic techniques. (2 q.h.)

INSTITUTION: RENSSELAER POLYTECHNIC INSTITUTE

PROGRAM: Environmental Engineering

DEPARTMENT: Chemical and Environmental Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Engineering (M.E.)
Master of Science (M.S.)
Doctor of Engineering (D.E.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. David Hansen, Chairman
Dr. William W. Shuster
Environmental Engineering Program
Chemical and Environmental Engineering Dept.
Rensselaer Polytechnic Institute
Troy, New York 12181
(518) 270-6377

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Chemical and environmental engineering are combined as disciplines at the Rensselaer Polytechnic Institute into the Chemical and Environmental Engineering Department. Rensselaer is one of the few institutions of higher education in the United States which offers a baccalaureate degree in environmental engineering. The Environmental Engineering Program builds on a broad base of studies in chemistry, life science, and engineering science in a three-year pre-engineering portion of the program, and during the senior year students receive specialized study in environmental engineering. The senior year consists of a sequence of courses designed around unit processes and integrated laboratory design courses. Employment for graduates of the program may be found in industry, consulting, government, research agencies and teaching.

On completion of the three-year pre-engineering curriculum, an undergraduate may continue to the two-year professional program leading to the Master of Engineering degree. Students electing the professional program may elect any of four options emphasizing water resources, solid waste, air pollution or radiological health. The Master of Engineering degree is awarded on completion of specified programs which are accredited by the Engineers' Council for Professional Development. The Master of Science degree is awarded on completion of a program which is individually arranged and appropriate to the major field. The Doctor of Engineering and Doctor of Philosophy degree programs are also arranged individually and emphasis is placed on advanced study in a specialty, with a major focus on thesis work. At the graduate level, students are encouraged to take cross-disciplinary studies using other Rensselaer courses outside of the department.

The department utilizes extensive research and instructional laboratories with a broad range of process and analytical instrumentation. Water resources laboratories are located at the Fresh Water Institute at Lake George. Current research is conducted in the study of water resources and its subtopics of treatment technology, environmental monitoring, and modelling of water ecosystems. Other environmental engineering research efforts are being directed in the area of air resources, solid wastes, radiological health, and other related areas. Some interdepartmental research is also being conducted with other departments in the areas of environmental acoustics, radiological health, water resources, and bioengineering.

PROGRAM REQUIREMENTS

Students seeking admission at the same level to the baccalaureate program must first be admitted to the university and satisfy the pre-engineering requirements. Junior college transfers can enter the program at the third year as long as their educational backgrounds are equivalent to what is offered during the first two years at Rensselaer. Department officials stated that prospective students should have taken four years of high school mathematics and science and have graduated in the top 10 percent of their class.

The Master of Engineering program, administered by the Professional School is EPCD-accredited, and graduates of other schools may be admitted with advanced standing and may normally complete the degree program in one year, if their baccalaureate engineering degrees are accredited. Master of Engineering candidates must: (1) be admitted to the Professional School of Engineering; (2) fulfull the general requirements; (3) complete the prescribed curriculum in the Professional School satisfactorily, and (4) complete an engineering project.

A total of 133 hours is required for completion of the Bachelor of Science degree in Environmental Engineering. In addition to the three-year pre-engineering program totaling 102 hours, the two-year Master of Engineering program requires completion of an additional sixty-one hours. The doctorate requires completing ninety credits beyond the bachelor's degree and a doctoral thesis or engineering project.

Although Rensselaer has established an Industrial Traineeship Plan, there is no sponsorship under this plan for environmental engineering students. The Chemical and Environmental Engineering Department does participate in a cooperative education program with industry. In the cooperative plan programs, students alternate periods of employment with periods of on-campus education; however, there is no financial support from the sponsor directly to the student's educational program.

Normal federal financial aid programs are available to students at the undergraduate level. At the graduate level, the only source of funding for students is research contracts. Training grants have almost disappeared and one U.S. Environmental Protection Agency fellowship is being funded. In addition, one industrial fellowship is available.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten faculty members are currently involved with teaching and research activities associated with the Environmental Engineering program. Many faculty members are involved in both portions of department's program. It is estimated that there are four and one-half full-time equivalent faculty members each involved with teaching and research.

At the undergraduate level during the pre-professional program, students are not identified as being environmental engineering oriented. While there are about twenty seniors in environmental engineering, this is out of a total of about 800 senior undergraduates in the engineering school. There are no part-time undergraduate environmental engineering students enrolled.

Fifty-four graduate students have chosen to specialize in environmental engineering at Rensselaer. Of these, forty are full-time students; two are female. There are fourteen part-time students taking graduate environmental engineering programs, and of these, one is female. It is estimated that 3½ percent of the undergraduate and 5 percent of the graduate students in the School of Engineering elect environmental engineering.

Within the last five years, an average of twenty-five undergraduates received baccalaureate degrees in environmental engineering at Rensselaer. At the graduate level, within the last three years on an average, twenty students have received master's degrees and three have received doctorates.

With the decline of training grants from the U.S. EPA, Rennselaer has felt less tied to offering specific curriculum specializations to environmental engineering students. Emphasis at the undergraduate level has been placed on providing students with a solid fundamental environmental engineering background. Master's students are required to complete a six-credit thesis, and the topic is usually in the student's chosen area of specialization. Approximately one-third of the master's program includes required fundamental courses. About one-half of the environmental engineering students elect to specialize in the water resources area. One-fourth elect the air option, and one-fourth select the other two remaining areas of concentrations.

Due to increasing governmental cutbacks in hiring, most of the environmental engineering graduates have found employment within private industry (mainly consulting firms.) There are a consistent number of graduates employed by industry involved in the design and manufacture of equipment for environmental control. Other graduates find employment with research groups and within academia.

PROGRAM PROJECTIONS

Although the Rensselaer environmental engineering program is not expected to significantly change in size and emphasis over the next five years, research programs may be expanded. Two additional environmental engineers with air or water resources backgrounds may be recruited for an expanded research program. An environmental science degree may be developed at Rensselaer within the School of Science as the Biology Department is active in environmental studies.

Rensselaer officials expect enrollment in environmental engineering to begin to level out, and keep pace with population trends. More emphasis in the next few years is expected to be in the application of chemical processing in the pollution control areas. The curtailment of the EPA training grant program has had a serious effect on the number of students entering environmental engineering graduate programs at Rensselaer. Departmental officials feel that there is a need to reinstate the EPA training grant program.

A main attraction of the Rensselaer environmental engineering program is the fact that it is one of the strongest undergraduate programs in environmental engineering in the United States. The graduate program is also considered to be one of the premier environmental engineering programs in the nation.

COURSE DESCRIPTION

32.405 Unit Operations in Environmental Engineering - A study of the physical processes, termed unit operations, that are common to air, water, and land pollution control systems. (3 s.h.)

32.406 Unit Processes in Environmental Engineering - The study of several physical-chemical and biological processes encountered in environmental pollution control and water supply. (3 s.h.)

32.407 Environmental Acoustics - A study of man's total sonic environment. (3 s.h.)

32.409 Water and Wastewater Engineering - The topics studies are: estimates of water demands, water supply sources, water quality criteria, transmission and distribution of water, water pumping and storage systems, rural water supply and other topics. (3 s.h.)

32.415, 32.416 Environmental Engineering Laboratory I & II- Experiments are performed in the areas of water, wastewater, solid wastes and air pollution. (2 s.h. each)

32.423 Air Pollution: Sources and Effluents - Fundamental aspects of air pollution with emphasis on emissions from major stationary and mobile sources (automobiles). (3 s.h.)

32.431 Solid Waste Engineering - Classification and characteristics of solid wastes, the need for and rating of solid waste management systems, design of municipal refuse collection and transfer systems, methods and costs of solid waste disposal, and other subjects. (3 s.h.)

32.442 Industrial Waste Treatment and Disposal - Physical, chemical and biological characteristics of industrial wastes. (3 s.h.)

Graduate Courses:

32.601 Public Health I - Occurrence and control of communicable diseases; principles of epidemiology and biostatistics and their application, emphasizing the relationship with environmental factors; air pollution sources and health effects. (2 s.h.)

32.602 Public Health II - International, federal, state and county health organizations, responsibilities, and functions; water quality management and public water supplies; solid wastes management; radiological health controls; air resources controls and management. (2 s.h.)

32.603 Chemistry for Environmental Engineers - The weekly 3-hour laboratory emphasizes analytical measurements using instrumental techniques; most experiments are drawn from the water and wastewater field, a few from air pollution. (3 s.h.)

32.611 Water Resources - Elements of meteorology and hydrology. Precipitation, runoff, stream flow, watershed losses, unit hydrograph, and groundwater problems. (3 s.h.)

32.612 Physical Chemical Waste Treatment - The application of theoretical principles and pilot plant data to the design and operation of advanced waste treatment systems. (3 s.h.)

32.614 Stream Pollution Control - The economic aspects of water pollution; health aspects of bacterial pollution. (3 s.h.)

32.616 Environmental Impact Analysis - Studies related to the evaluation of the impacts of major actions by state and federal agencies on the quality of human environment. (3 s.h.)

32.620 Atmospheric Chemistry - The course presents important thermodynamic and kinetic aspects of reactions in the atmospheric layer. (3 s.h.)

32.622 Air Pollution Meteorology - Investigation of atmospheric processes of particular importance in dealing with the environmental problems of air pollution. (3 s.h.)

32.624 Air Pollution Control - The major approaches to air pollution control are discussed from three different viewpoints. (3 s.h.)

32.634 Environmental Radiation Safety Controls - Consideration and control of the health hazards peculiar to the atomic industry. (4 s.h.)

INSTITUTION: RUTGERS - STATE UNIVERSITY OF NEW JERSEY

PROGRAM: Environmental Science

DEPARTMENT: Environmental Science

DEGREE: Master of Science (M.S.); Doctor of Philosophy (Ph.D.)

CONTACT: Professor A. Joel Kaplovsky
Director of Graduate Programs in Environmental Science
401 Georges Road Laboratories, Cook Campus
Rutgers - State University of New Jersey
New Brunswick, New Jersey 08903
(201) 932-9571

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Science at Rutgers has long-standing multidisciplinary graduate teaching and research programs since inception in 1920. This problem-oriented program deals primarily with technological solutions to the contamination of our environment from particulate matter, gases, vapors, liquids, and undesirable organisms. Emphasis is placed on the application of the physical, chemical, and biological sciences toward this end. The following areas of specialization are offered: air resources; aquatic biology; aquatic chemistry; chemistry and physics of aerosol and hydrosol systems; environmental chemistry; environmental microbiology; water and wastewater treatment (wastewater is largest area of emphasis); and water resources.

The Environmental Science Program at Rutgers is the oldest of its kind in the United States, and deals with chemical and biological application to the solution of environmental problems. A specialized research group, Rutgers graduates from the Environmental Science Department are qualified for positions in the environmental field where expertise is needed for solutions of problems in which the air, water, solids, and pollution interact. Trained as multidisciplinary scientists, graduates may obtain positions as researchers and as high school and college instructors. They may also find positions within private industry working on waste problems as either industry employers or as consultants. Positions within government may be found in administration, enforcement, research, inspection, and control. Positions for the program's graduates exist at treatment facilities in the capacity of supervisor, director, analyst, technician, and operator.

The department's Environmental Science Laboratory is staffed with bench-oriented, problem-solving scientists in the pollution field Facilities are available for the solution of problems ranging from the most simple and practical to those requiring sophisticated analytical capabilities.

Seminars and a large non-degree short course program are conducted by Departmental faculty. Forty percent of the short course teaching load is in the areas of air, wastewater, water supply, and solid wastes. An environmental training center has been developed and one short course consists of seven days a week for air, wastewater, solid wastes and water supply training.

PROGRAM REQUIREMENTS

In order to enter the Environmental Science Program, prospective students must have a strong science-based background including chemistry, physics, biology, mathematics. No students without a chemistry background will be accepted into this program. Verbal and aptitude scores from the Graduate Record Examination are required and students must have a grade point average of 2.5 on a one point (high) scale.

In order to obtain the Master of Science degree, 30 credits of required course work (the research M.S. requires 24 credits plus a 6 credit thesis), which represents 50 percent of the selected program of study, must be fulfilled. Research is required to be in the major field of study, and is a twelve month program which requires an advisor. A candidate for the Doctor of Philosophy degree must normally spend not less than one academic year or two consecutive terms, excluding the summer session, as a full-time student in residence. A foreign language requirement for the doctorate is stipulated, and can be fulfilled either by examination or by course work (without credit), as approved by the program faculty. Forty-eight hours of course work plus twenty-four hours of research are required for fulfillment of the doctorate.

Research funding is available from the U.S. EPA, the National Science Foundation, the National Institute of Health, the Army Corps of Engineers, and the Department of Energy. The New Jersey Department of Environmental Protection and private industry also fund research concerning waste problems associated with air, water and solids pollution.

A variety of financial aid is available to graduate students and include research contracts, training contracts, industrial fellowships, teaching assistantships, coadjuncts and loans. The Danforth, Woodrow Wilson and Ford foundations offer fellowship programs for graduate students. The National Science Foundation offers graduate fellowships for beginning graduate students. Various publicly and privately sponsored fellowships include stipends ranging from $2,000 to over $5,000 a year and usually cover remission of normal tuition charges, including six summer credits. Teaching and graduate assistantships provide salaries beginning at about $3,969 or year with remission of tuition charges for both the fall and spring terms, plus an additional remission allowance (6 credits) for optional summer study. Assistants are usually required to spend up to fifteen hours per week on their jobs, whether in teaching or research.

CURRENT FACULTY, STUDENTS, GRADUATES

Twenty faculty members contribute to the teaching and research conducted by the Environmental Science Department. Only twelve faculty are involved in full-time teaching activities and fourteen staff teach the Department's courses. Fourteen staff members are involved in research activities.

There are currently 130 students enrolled in the Environmental Science Program and 70 are full-time students. Ninety of the students are male and forty are female (there are no female part-time students). Officials estimate that approximately 40 students annually receive degrees, on the average. Enrollment appears to be steadily increasing in the Environmental Science Department over the past several years.

All those graduating from the Department find employment directly related to their training. Approximately 35 percent of recent graduates find private sector industrial and consulting positions. Another fifteen percent obtain teaching positions within academia and the remaining 50 percent find public sector jobs. Many employers call the Department seeking to employ graduates from the program and this is considered by program officials to be an excellent method of finding employment.

PROGRAM PROJECTIONS

Because of recent rising enrollment trends additional faculty in the chemical and toxicity specialty areas may be recruited within the next five to ten years. Expansion of staff often takes a great deal of time because of the requirement of justifying growth. Program officials find that because of the complexities and work to be performed in this field, the present staff could be easily doubled in size.

The Environmental Science staff has considered developing Master's degree programs in environmental health and occupational health (industrial hygiene). Because the Rutgers program currently is stronger in the pollution sciences than others, wastewater aspects relating to health problems would be emphasized. Recent research has indicated that environmental and occupational health fields have been largely overlooked. Fields such as toxicology and epidemiology are needed to study the effects of low level pollution that is concentrated in the environment because they impact on man. Rutgers is uniquely situated to study such effects because eleven percent of the chemical industry in the nation is located in New Jersey. There is an unlimited potential for expansion in both teaching and research in the chemical and toxicity fields. To adequately begin research in this area, the Rutgers program would have to double its present staff and all present programs should be expanded in a sophisticated direction.

COURSE DESCRIPTION

(the following is a partial listing of courses offered)

Graduate courses 16:375:

501 Waste Treatment I: Sewage Treatment - Physical, chemical and biochemical processes utilized to treat municipal wastewaters. (3 s.h.)

502 Stream Sanitation - Principles of biological stabilization of pollution materials in streams; factors influencing atmosphere reaeration; changes in biological populations in polluted waters. (3 s.h.)

503 Analytical Techniques in Environmental Chemistry - Theory and techniques of analytical procedures applicable to research in environmental science. (3 s.h.)

504 Waste Treatment II: Water Treatment - Chemical, physical, and biological factors affecting development of water supplies; water quality; municipal and industrial water treatment processes. (3 s.h.)

508 Application of Principles to Treatment Problems - Application of fundamental principles concerned in water purification and liquid and waste treatment processes to design and operation problems. (3 s.h.)

510 Pollution Microbiology - Bacteria as indicators of sanitary conditions; liquid and solid waste treatment processes. (3 s.h.)

517, 518 Principles of Environmental Science - Principles and interaction associated with air environment, water environment, and environmental health. (3 s.h. each semester)

524 Source Control of Atmospheric Pollution - Principles, operation, performance, and application of methods and devices to control aerosol and gaseous emissions. (2 s.h.)

525 Principles of Solid Waste Management and Treatment - Solid waste problems in the municipal, industrial, and agricultural areas. (3 s.h.)

526 Limnology of Urban and Suburban Waters - Study of waters stressed by population, development, wastes. (3 s.h.)

INSTITUTION: SAM HOUSTON STATE UNIVERSITY

PROGRAM: Environmental Science

DEPARTMENT: Environmental Sciences (Division)

DEGREE: Bachelor of Science (B.S.) in Environmental Science

CONTACT:

Dr. James R. DeShaw
Associate Professor, Biology
Sam Houston State University
Huntsville, Texas 77340
(713) 295-6211 x2292

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The interdisciplinary Bachelor of Science degree in environmental science was established at Sam Houston State University in 1970. Program emphasis is on the sciences and mathematics.

The graduates of this program enter occupations in health, environmental and analytical fields. Employers include city, county, state and federal agencies. The petrochemical industries of the Gulf Coast are also major employers of these program graduates. Graduates entering these industries are utilized in areas of research, waste treatment, surveillance and quality control. Historically, these students have chosen a career path upon completion of the baccalaureate degree.

PROGRAM REQUIREMENTS

Although there are no special requirements for entrance into the environmental sciences program, students entering at the third year must have completed the first two year schedule of courses. Therefore, early identification of this program as the major would be helpful to the student.

Requirements for the first two years include completion of the following: 23 semester hours in English, history, government and physical education; 28 semester hours of chemistry, physics and mathematics; and, 15 semester hours in biology, geoscience, and environmental science.

During the third and fourth years the student must complete 62 semester hours of course credit which include: 15 semester hours of government, economics and humanities electives; 10 semester hours of chemistry; 20 semester hours of chemistry; 20 semester hours of biology and environmental sciences; and, 17 semester hours of restricted electives from the areas of agriculture, biology, chemistry, geography, geosciences or computer sciences.

An internship program is being developed but is not, at present, part of the requirements for completion of the baccalaureate degree in environmental sciences.

CURRENT FACULTY, STUDENTS, GRADUATES

Current faculty members include three full-time teaching personnel. All have achieved their Doctor of Philosophy degree and have conducted research in appropriate areas.

The student enrollment, at present, totals 35. Of the 35 total students, 28 are male and seven are female. Approximately 83% of the students are on some form of scholarship.

Graduates have averaged approximately 12 per year over the last three years. Approximately 25% of these graduates continue their education in pursuit of higher degrees. The University of Houston, Texas A & M and Rice University are the usual recipients of the continuing students.

PROGRAM PROJECTIONS

Long range plans for this program include growth in both student enrollment and faculty. By the end of 1978 the faculty is anticipated to have increased by one part-time environmental science teacher.

Program changes include the addition of an industrial hygiene course and a summer internship program which is still in the formative stages. An energy course from the physics department may be added to the restrictive electives.

COURSE DESCRIPTION

EnvSci 147 Environmental Science - A general course designed to cover all areas relating to contemporary ecological problems. (4 s.h.)

EnvSci 330 Legal Aspects of Pollution Control - A study comparing various state and federal laws with particular emphasis on the State of Texas statutes will be conducted. Nature of evidence for prosecution under these laws will be considered. (3 s.h.)

EnvSci 341 Instrumentation - Theory and practice of analytical methods used in the field of Environmental Science. (4 s.h.)

EnvSci 343 Water Supply and Wastewater Disposal - Water supply, development, treatment and distribution; wastewater collection and treatment; water purification and reuse; and the chemistry and ecology of aquatic systems are studies. (4 s.h.)

EnvSci 440 Air Pollution - An indepth study of the sources of air pollution is made. Sampling procedures and the chemical analysis required for identification of pollutants are studied. Control methods for the restriction of air pollution are outlined. (4 s.h.)

INSTITUTION: SLIPPERY ROCK STATE COLLEGE

PROGRAM: Environmental Studies (Interdisciplinary)

DEPARTMENT: School of Natural Sciences and Mathematics

DEGREE: Bachelor of Science in Environmental Studies

CONTACT: Murray A. Shelgren, Professor
Environmental Studies Program
Slippery Rock State College
Slippery Rock, Pa. 16057

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This interdisciplinary Environmental Studies Program at Slippery Rock State College was initiated in 1971 to prepare students for technical and administrative positions in industry, city and state health departments, planning commissions, and state and federal environmental agencies. The program is also designed to prepare students for graduate studies in environmental sciences. A systems approach is taken in instruction relating to chemical, physical and biological measurements in the environment. Recent graduates have obtained jobs as researchers, industrial hygienists (air sampling and monitoring), water pollution control engineers, air pollution engineers, aquatic biologists, environmental engineers, sewage plant operators, and sales and technical representatives.

The program utilizes fully equipped laboratories with atomic absorption spectrophotometers, microbiological, stack sampling and other related equipment. The laboratories in the departments of Biology, Chemistry and Geology are available to the students as well as the facilities of the Computer Science Department. The aquatic laboratory contains electroshocks and all other standard aquatic sampling equipment. A twenty-five foot pontoon boat has been set up as an aquatic and two sixteen foot runabouts are also at a biological field station on a 3,000 acre lake in a 15,000 acre park located nearby. Field trips are also taken to Lake Erie and other locations within a one hundred mile radius of the college. Approximately fifty percent of the program's courses involve field trips and the use of laboratory equipment in the field is an effective teaching tool.

PROGRAM REQUIREMENTS

Students must meet the entrance requirements of the college in order to enter the program. Transfer students from other science areas as well as transfers from junior colleges are also accepted.

A total of 128 semester credits are required for graduation and a student may elect with Track 'A' Air and Water Pollution or Track 'B' Ecological Planning. Common requirements for both tracks include a seminar, a research methods course, a field problems course, and two computer languages or equivalent courses. A three semester hour field problem for the Air and Water Pollution major is also required. courses, sixteen hours of elective courses, twenty hours of related courses and six hours of suggested courses are also part of the curriculum. Incorporated are biology, chemistry, geography, economics and mathematics courses.

Although there are no specific financial aid grants available through the Environmental Studies Program, the Pennsylvania Higher Education Assistance Agency provides State Grants, State Guaranteed Loans, and State Student Employment funds. Other normal federal programs such as the Supplemental Educational Opportunity Grant Program are also available to students.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of fourteen faculty members from nine departments contribute to the teaching of the courses offered in this interdisciplinary program. Two each of the faculty are from the biology, geology and chemistry departments and eight are from six other departments. However, only four professors teach the bulk of the courses which are the heart of the program.

There are currently fifty students enrolled full-time in the Environmental Studies Program and between ten to twenty percent are females. Approximately eight to ten students graduate with the Bachelor of Science degree annually. The number of students enrolled in the program has been steadily increasing in recent years, however, class size has remained small.

About twenty percent of the graduates have continued at other educational institutions for advanced degrees. Most of the students continuing their education are supported by their employers in continuing into sanitary engineering or public health programs offered by the University of Cincinnati or the University of Pittsburgh.

The College has had a 93 percent success rate in placing students in their field. About 5% find jobs in a related field and two percent in an unrelated field. Most (90%) find jobs with consulting firms and few (5%) find jobs with governmental agencies or other types of employers. Assistance in obtaining employment is provided by the College's Placement office and three faculty member's contacts with private firms.

PROGRAM PROJECTIONS

Although there are no current plans to develop new programs in this area by the college, the Environmental Studies Program is being modified and upgraded. It is likely that enrollment will increase and an engineering orientation (electronics, physics) will be taken. The current emphasis has been with Chemistry and Biology using "Standard Methods for the Examination of Waters and Wastewaters" as a central core. For example, a radiation course will be incorporated in future curriculums instructing basic techniques. Because of a current tight fiscal budget, the hiring of additional faculty is not anitcipated. In sum, the Environmental Studies Program will expand in a sense in that current courses will be upgraded and a certain reshuffling will be undertaken to meet employer needs.

COURSE DESCRIPTION

BIO 305 Aquatic Plants - Emphasis on the productivity of aquatic plants and their importance as indicator organisms. (3 s.h.)

BIO 306 Aquatic Animals - Emphasis placed on the productivity of aquatic animals and their importance as indicator organisms. (3 s.h.)

BIO 105 Environmental Biology - An introduction to ecological principles and concepts with an examination of the contemporary environmental problems. (3 s.h.)

CHEM 370 Water Pollution - Water quality assessment and water quality problems will be examined both in lecture discussions and in laboratory or field situations. (4 s.h.)

CHEM 430 Industrial Pollution Control Engineering - Economic and technical problems will be discussed as related to the abatement of harmful discharges from industrial sources. Systems analysis will be employed in the examination of engineering solutions. (3 s.h.)

GEOG 135 Environmental Problems - An introduction to some of the more crucial problems which arise with the environment, and the alternative solutions which are available. (3 s.h.)

GEOG 235 Resource Conservation - The utilization of the nation's resources, the need for conservation, the prevention of waste, and the problems of instituting wise conservation programs. (3 s.h.)

REC 340 Environmental Resource Analysis - A study of the principles and techniques of environmental resource analysis, landscape and scenery classification, and procedures for environmental quality and impact analyses. (3 s.h.)

Other courses:

GEOL 360 Water Resources - A study of the occurrence and movement of water and man's attempt to preserve this basic resource. (3 s.h.)

GEOL 451 Environmental Geochemistry - A study of the theory and applications of the role of the aqueous sedimentary interface equilibria and environmental pollution. (3 s.h.)

HSE 444 Epidemiology - The study of the principles and conditions of disease including agent, host and environmental factors. An overview of patterns of disease occurrence and the nature of epidemiological research. (3 s.h.)

BIOL 210 Medical Microbiology - The study of pathogenic microorganisms to include taxonomy, structure, biological activities, host defense mechanisms, disease transmission and states. (3 s.h.)

BIOL 304 Applied Microbiology - The study of those aspects of microbiology which directly affect human affairs with special attention given to environmental protection, agriculture, food technology and public health. (3 s.h.)

CHEM 340 Air Pollution - A study in the quality of the air environment. Air quality assessment and potential problems will be examined both in lecture discussions and in laboratory or field situations (includes ambient air testing, source testing, and industrial hygiene testing). (3 s.h.)

INSTITUTION: SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

PROGRAM: Environmental Technology
DEPARTMENT: Environmental Technology
DEGREE: Associate in Science

CONTACT:
John T. Donohue, Chairman
Division of Engineering Technologies
Springfield Technical Community College
Armory Square
Springfield, Massachusetts 01105

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This two-year Environmental Technology Program integrates two technical environmental options: Quality Technology, and Wastewater Treatment Technology. Formerly, these two options had separate curriculum structures but now are offered in one curriculum. The orientation is toward environmental engineering with the goal of training students to become para-professionals to assist an engineer. Their functions would include detecting and measuring pollution, installing control facilities, and operating purification facilities. It is anticipated that graduates would qualify for positions in industrial facilities, governmental agencies, municipal engineering offices, engineering firms, waste treatment plants and manufacturers representatives. This career-oriented program has not been designed to enable a student to transfer to a four-year college program. Springfield Technical Community College is an accredited member of the New England Association of Schools and Colleges.

The Department of Environmental Technology offers extensive facilities to assist students in receiving "hands-on" instruction. The program utilizes a complete chemical laboratory, a small model of an activated sludge filtration system, and air and water sampling equipment. Water samples are also picked up by the department from the Springfield waste treatment facility for analysis by students in the laboratory. In addition the program emphasizes its summer practicum between the first and second year in which students work forty hours a week for five weeks at treatment facilities (12 to 15) located within a 75-mile radius of the college.

PROGRAM REQUIREMENTS

In order to be considered for admission into the Environmental Technology Programs, prospective students must have had one year of chemistry and two years of algebra or its equivalent. Structured into the four semester curriculum (including the summer practicum) are sixty-eight credit hours of requirements. Included are courses covering the topics of process problems, environmental microbiology, technical report writing, treatment plant operations, industrial health and safety, water sample, analysis and control processes, systems maintenance, and air sample, analysis and control processes.

Most of the forms of financial aid available to students consist of the Basic Educational Opportunity Grant Program and Work-Study. Limited amounts are available from other funding sources.

CURRENT FACULTY, STUDENTS, GRADUATES

Two full-time faculty members contribute to the Environmental Control Technology Program of instruction. Currently (fall, 1977) the program has an enrollment consisting of twenty-six full-time male students, and approximately 10 students graduate annually on an average. Enrollment appears to be slowly increasing over the past few years.

Although this program is designed to be terminal, about eight to ten percent of the graduates continue on for higher education, although most find employment as waste treatment plant operators. For example, some of the program's graduates have changed their original career objectives midway through completion of the program and are enrolled in a general environmental science program (bachelor's) offered by the University of Maine. Although the college assists students in their employment search through its placement office, students often have more success securing jobs through participation in the summer practicum and responding to employers inquiries made to the department. Program officials estimate that 95% of the graduates obtain employment in their field and 5% in a related field Although most (80%) find government jobs, some students (20%) find jobs in the private sector, mostly in paper mills.

PROGRAM PROJECTIONS

The Environmental Technology Department is not anticipating hiring additional faculty members over the next five years as the program can accomodate more students with present staff. The program is flexible enough in orientation to be able to adapt to changing needs but current emphasis is on the development of the program's current resources.

The need to train wastewater treatment plant operators is expected to continue to increase although the need will begin to level off once the plants are built. However, department contacts do not anticipate that they are anywhere near a saturation point in the near future.

COURSE DESCRIPTION

6183 Wastewater Sample and Process - An investigation of the chemistry of domestic and industrial liquid wastes, their effects upon wastewater treatment plants and processes and the test procedures and techniques required for treatment plant operation. (3 s.h.)

6186 Environmental Studies - An introduction to environmental pollution, its effect on man and other living things and the basic principles of sanitation, treatment and control. (3 s.h.)

6190 Systems Operations and Maintenance - A study of wastewater treatment plant equipment with emphasis on diagnosis and repair and preventive maintenance programs. (3 s.h.)

6192 Treatment Plant Unit Operations I - An investigation of the physical and chemical processes utilized in the treatment of liquid wastes. (3 s.h.)

6197 Air and Water Quality Control Processes - A study of the processes utilized to reduce or eliminate pollution of the atmosphere. (3 s.h.)

6200 Air and Water Sampling and Analysis - An investigation of the equipment and techniques used in atmospheric sampling and of the instruments used to analyze the samples. (3 s.h.)

6201 Industrial Health and Safety - An investigation of the procedures and attitudes required so that man may safely work in the vicinity of industrial processes and equipment. (3 s.h.)

6234 Basic Instrumentation - A study of electrical, electronic and pneumatic basic and operating principles as applied to instrumentation used for the measurement and control of process variables. (3 s.h.)

6328 Treatment Plant Unit Operations II - An investigation of the physical and chemical processes utilized in the treatment of liquid wastes. (3 s.h.)

INSTITUTION: STEVENS INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Engineering, Environmental Science

DEPARTMENT: Mechanical Engineering

DEGREE: Master of Engineering (M.E.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Fernando Sisto, Jr., Head
Mechanical Engineering Department
Stevens Institute of Technology
Castle Point Station
Hoboken, New Jersey 07030
(201) 792-2700

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Engineering and science students may enter an interdisciplinary program in Environmental Engineering/Science (also referred to as Environmental Systems) and complete an M.S., M.E., or Ph.D. in Environmental Systems under the supervision of an interdisciplinary advisory committee. Each graduate student completes a core of courses in environmental chemistry, mathematical models (including computer methods), fluid dynamics and thermodynamics, which are required for all environmental areas of specialization. In addition to the general environmental systems core, each student completes additional work to emphasize his/her specialization, such as water and water quality control, air pollution control, noise pollution control, thermal pollution control, and solid waste management and resources recovery. This program was initiated in 1978.

PROGRAM REQUIREMENTS

For admission to the program, students must meet the entrance requirements for graduate study at Stevens Institute of Technology. A bachelor's degree in engineering or science from an accredited college or university is required for admission. M.S. and Ph.D. degrees can be pursued by both engineering and science students; however, the M.E. degree can only be pursued by a student with an engineering degree.

The minimum requirements are thirty credits for the M.S. or M.E. degree. The maximum number of credits that may be transferred from other institutions is ten. A master's thesis is optional.

The minimum requirements for the Ph.D. degree are ninety graduate credits beyond the bachelor's degree. The maximum number of credits that may be transferred is thirty for the Ph.D. degree. The doctoral student must spend one year "in residence" performing research. Within one year after admission to the doctoral program or after receipt of the master's degree, whichever comes first, the student must take a qualifying examination. The preliminary examination must be taken at least one year before the degree is awarded. Foreign language requirements are left to the discretion of the interdisciplinary advisory committee. A doctoral student is officially admitted to candidacy when he/she has completed satisfactorily all requirements except the completion of the dissertation and the final examination in defense. A minimum of thirty credits is required for the Ph.D. dissertation.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight faculty members, six full-time and two part-time, are currently participating in the environmental systems program. About one-third of the faculty time is devoted to research, with the remainder in teaching. Research funding in environmental systems is being sought from different governmental agencies, and industry.

Presently, there is one full-time graduate student in the M.E. program. As the interdisciplinary environmental program began in early 1978, there have not yet been any graduates.

PROGRAM PROJECTIONS

Program officials expect an expansion in the environmental systems program at both the master's and Ph.D. levels in the near future. The M.E. degree in environmental systems offered by S.I.T. will meet the general ECPD criteria for advanced level accreditation.

COURSE DESCRIPTION (SELECTED)

CE 74 Sanitary Engineering - An environmental engineering course oriented to the control of air, water, land, noise and thermal pollution. Topics covered are: sources and nature of pollution, pollution effects, control of communicable and certain noninfectious diseases, source and protection of water supply, prediction and dispersion of airborne effluents, pollution control technologies, solid waste handling and disposal, ventilation and air conditioning, radiation uses and protection, food protection, vector and weed control, pesticide use, energy and resources recovery and thermal pollution control in streams. Environmental analytical techniques are briefly introduced and practiced.

CE 75 Environmental Systems - Water supply and sanitation systems; water runoff and conservation; hydrology and stream flow; flow in pipes and open channels; networks; water treatment; water distribution; sanitary sewers; storm sewers; treatment plants;

CE 75 (Cont'd) - pumping and regulating chambers; biological processes; physical-chemical processes; field trips to local sites of interest.

MS 47 Ecology and Social Costs - Problems involving the interaction between the environment and selected areas of the economy are investigated with heavy emphasis on the collection and analysis of data; typical areas include: use of recreational land, recycling waste material, pollution control, evaluation of costs and benefits of environmental movements.

ME 113 Introduction to Nuclear Engineering - A development of the background necessary for nuclear engineering, beginning with a review of atomic physics and including radioactivity, nuclear reactions, neutron physics and elementary reactor theory, reactor dynamics and control, reactor types, metallurgy of reactor materials, heat transfer and fuel element design.

ME 133 Biological Treatment of Wastewater - Biological basis of wastewater treatment; river-wastewater treatment works analogy; population dynamics; food sources; aerobic and anaerobic systems; reaction kinetics and parameters affecting waste removal; fundamentals of mass transfer and gas transfer; trickling filter; activated sludge process; aerated lagoons; stabilization ponds; nitrification; dentrification; sludge concentration; aerobic sludge digestion; anaerobic sludge digestion, sludge conditioning; sludge drying, vacuum filtration; incineration; and ocean disposal. A biological treatment plant design project is included.

ME 134 Chemical and Physical Treatment of Water and Wastewater - A study of the chemical and physical operation involved in treatment of potable water, industrial process water and wastewater effluent; topics include chemical precipitation, coagulation, flocculation, sedimentation, filtration, disinfection, ion exchange, oxidation, adsorption, flotation, and membrane processes. A physical-chemical treatment plant design project is an integral part of the course. The approach of unit operations and unit processes is stressed. Physicochemical treatment are conducted.

ME 135 Sanitary Plumbing Systems Laboratory - Experimental and analytical treatment of problems of supply of potable water to residential and commercial buildings. Conveyance of wastewater in multistory and multiuse structures. Theoretical and practical bases of codes and design procedures. Aesthetic and economic considerations. Laboratory verification of theoretical concepts involved in design and analysis of systems. Analog modeling of supply and disposal systems.

ME 140 Origins and Analyses of Air Pollutants - Atmospheric and source emission testing of air pollutants; laboratory and field work involving sampling and testing for the concentrations of particulates, nitrogen oxides, hydrocarbons, carbon monoxide and sulfur dioxide in the atmosphere and in chimneys; stack

ME 140 (Cont'd) - emission testing for carbon dioxide and oxygen; dispersion models for air pollutants; national air quality standards, air quality criteria; federal and state laws, local ordinances.

ME 141 Air Pollution Control - Control of pollutant emissions from vehicles and from stationary industrial sources; particulates, nitrogen oxides, carbon monoxide, hydrocarbons, sulfur dioxide and others; cyclone separators, electrostatic precipitators, baghouse collectors, scrubbing, absorption, adsorption, afterburning, and others; combustion of fossil fuels and equilibrium concentration calculations; combustion modification and flue gas recirculation for pollutant emission control.

ME 145 Site and Environmental Planning - Assessment of the environmental impact of a proposed project; methods of analysis of environmental factors affecting a variety of projects through case studies; establishing a procedural guideling for making environmental impact statements; preparation of an environmental assessment report analyzing an environmental problem confronting a community in the New York-New Jersey metropolitan area.

ME 167 Acoustics - Fundamentals of vibration, plane wave, spherical waves, sources, receivers, resonators, ultrasonics, absorption, speech, hearing, noise, architectural acoustics.

ME 168 Acoustics Laboratory - Experiments illustrating principles, practices, instrumentation for acoustics; sources, receivers, absorption, standing waves, resonators, room acoustics, underwater acoustics.

ME 171 Noise Control - Behavior of sound waves in air; psychoacoustics; criteria for hearing conservation; criteria for noise and vibration in communities, buildings, and vehicles; sound and vibration transducers; field measurements; data analysis; architectural acoustics; noise control techniques; previous experience in acoustics is not required.

ME 173 Waste Heat Disposal - Methods of disposing of large quantities of low grade heat energy will be discussed. Included will be once through cooling with surface or submerged discharge into lakes, rivers, and estuaries; wet and dry cooling tower performance; spray canals and cooling ponds; methods of utilizing the energy, e.g., aquaculture, heating, agriculture.

ME 190 Environmental Law for Practicing Engineers - Review of laws regarding air, water and noise pollution. Role of engineer representing a company or the public before governmental agencies. Permit system, implementation plans, and other legal sanction. Site studies and environmental impact statements.

INSTITUTION: SYRACUSE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Environmental Engineering

DEGREE: Bachelor of Science (B.S.)

CONTACT: Dr. James A. Luker
Dean, College of Engineering
Syracuse University
Syracuse, New York 13210
(315) 423-4341

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental engineering program is designed to provide a strong background in engineering sciences while also preparing engineers for evaluation and solution of environmental problems. It is a broad-based program which encompasses four areas of environmental concern: air, water, solid waste, and noise.

This program, which was initiated in 1971, allows students considerable flexibility in determining their own programs of study to meet their needs and interests. An interdisciplinary committee of faculty members from the various engineering departments directs the program and a faculty advisor from this committee advises each student in the development of an individual program. Support facilities for the program are the laboratories and facilities of the other engineering departments, principally civil and chemical.

PROGRAM REQUIREMENTS

Admission to the program generally requires a high school diploma and scores from either the Scholastic Aptitude Test or the American College Test. Transfer students from community colleges and other four-year institutions are encouraged, with few restrictions on the acceptance of transfer credits. It is generally required, however, that transfer students complete the environmental engineering courses at Syracuse.

A minimum of one hundred and twenty-six credit hours are required for completion of the program. Included are at least twenty-nine hours of engineering science and fifteen hours of engineering design. Although a student can specialize in a particular environmental area, at least one course must be taken in each of the four areas: air, water, solid waste, and noise. Two additional courses must also be taken in air or water. Three credit hours of independent study and three hours of environmental engineering design are also required.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of twelve faculty members participate in the environmental engineering program on a part-time basis. All have full-time assignments to other departments and conduct research in their primary departments.

There are currently forty-four students in the program, all full-time. A number are career change, coming from other disciplines such as biology or forestry. Officials indicated that approximately sixty percent of the students are in-state residents. Recruitment is done chiefly through the university and some students are receiving financial assistance through university scholarships.

Approximately twelve students per year graduate from the program and this figure remains fairly constant. About twenty-five percent of the graduates go on for further degrees and of the remainder, almost seventy-five percent find employment in the private sector. Graduates are placed through faculty contacts and the university's placement service.

PROGRAM PROJECTIONS

There is no expansion foreseen in the program or faculty for the near future.

COURSE DESCRIPTION (SELECTED)

CEN 511 Environment Monitoring Instrumentation - Experimental techniques of sampling and analysis of gaseous, liquid and solid waste. Principles and operation of modern instruments to measure very low concentration of air and water pollutants, including the evaluation of typical data. (3 s.h.)

CEN 545 Physiochemical Methods in Waste - General survey on the applicability of chemical engineering unit operations and unit processes in fluid waste treatment. Membrane process, including electrodialysis and reverse osmosis, IPC (Independent Physical and Chemical) process of waste treatment, coagulation, deep bed filtration, and carbon column operation. (3 s.h.)

CEN/MEE 547 Chemistry and Transport of Air Pollutants - Photochemical, thermal, and heterogeneous reactions of gaseous pollutants, transport equations, air pollution climatology, dispersion modeling and forecasting potential air pollution occurrences. (3 s.h.)

CEN 573 Principles and Design in Air Pollution Control - Fundamental principles of pollution control, design of control

CEM 573 (cont'd)
processes and equipment, criteria for selection of control processes and equipment for gaseous and particulate pollutants. (3 s.h.)

CIE 453 Water Resources - Occurrence, distribution, and statistical analysis of rainfall and river flow. Relationships of rainfall to runoff. Prediction of drought and flood frequencies and quantities. Surface and subsurface water storage. (3 s.h.)

CIE 454 Treatment of Water and Waste Water - A comprehensive study of the theories and applications of unit processes utilized in rendering water acceptable for domestic and industrial consumption and waste waters acceptable for discharge into receiving systems. (3 s.h.)

CIE 551 Sanitary Engineering Theory I - Theoretical basis for analytical procedures and for treatment of water and waste water. Laboratory determination of constituents. (3 s.h.)

CIE 553 Sanitary Engineering Theory III - General principles of sanitary microbiology, with special emphasis on the role of lower protists (bacteria and blue-green algae) in the ecology of streams lakes, water treatment, and waste water treatment processes. (3 s.h.)

CIE 558 Solid Wastes: Collection and Disposal - Composition of refuse; quantities produced by individuals and industries; collection equipment, methods and associated costs, type service, including contracts; financing and cost accounting; disposal problems, solutions, such as landfills, incineration, composting; combined disposal with industrial wastes. (3 s.h.)

CIE 561 Air Resources I - Occurrences, nature and properties, major sources and quantities of contaminants; ambient air concentration levels, community distribution patterns and control of air pollution. (3 s.h.)

MEE 483 Introductory Acoustics and Noise Control - Sound. Introduction to acoustics. Sound pressure level and ear response. Simple noise control. Field work: measurement of airport, traffic and office noise with mobile acoustics laboratory. (3 s.h.)

MEE 555 Combustion-Generated Air Pollution - Introduction to basic combustion mechanisms. Major combustion air pollution sources are investigated and design variables which affect emission levels analyzed. (3 s.h.)

MEE 565 Combustion Engineer Emissions - Role of motor vehicles in air pollution. Engineer operation, fuels. Emission formation in gasoline, diesel, and gas turbine engines. Federal test procedures. (3 s.h.)

INSTITUTION: TEMPLE UNIVERSITY

PROGRAM:
Environmental Technology (A.T.)
Environmental Engineering Technology (B.S.)

DEPARTMENT: Civil and Environmental Engineering Technology

DEGREE:
Associate in Technology (A.T.)
Bachelor of Science (B.S.)

CONTACT:
Dr. Frederick B. Higgins
Chairman of the Department of Civil and
Environmental Engineering Technology
Temple University
Philadelphia, Pennsylvania 19122
(215) 787-7816

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The College of Engineering Technology offers two degree programs relating to environmental pollution control; Environmental Technology and Environmental Engineering Technology. The Environmental Technology Associate degree curriculum is oriented toward the training of engineering technicians to perform environmental measurement and control tasks for either industry or governmental agencies. This program is accredited by the Engineer's Council for Professional Development and graduates are trained for positions as air pollution technicians, laboratory technicians, service technicians, technical representatives, and water quality technicians.

The Environmental Engineering baccalaureate curriculum is based on chemistry, biology, civil engineering, and chemical engineering aspects which would be most appropriate to study environmental quality deterioration and to the design of equipment or systems for pollution abatement and control. Students prepare for the practical application of control technology to pollution control and abatement. Students may select electives to emphasize engineering, social or management aspects. Graduates may obtain positions as project engineers with consulting companies in environmental control groups in industry, or in regulatory agencies.

The two programs utilize a wet chemistry laboratory for the analysis of environmental pollutants and an instrumentation laboratory which contains automated air and water pollution monitors. In addition, a bacteriological laboratory is available for students to use. Several pilot treatment plants are also available.

PROGRAM REQUIREMENTS

In order to be eligible for admission at Temple University sixteen units (one unit - one year) of acceptable high school work are required of which ten must include four units of English, two units of college preparatory mathematics, one unit of history, one unit of laboratory science and two units of a foreign language. College of Engineering Technology students are not required to satisfy the foreign language requirement but must instead present two additional units of mathematics and laboratory sciences.

The two-year Environmental Technology curriculum includes 66 semester hours of required courses plus an environmental field operations course (4 semester hours) during the summer between the second and third semesters. The four year Environmental Engineering Technology curriculum includes 124 credit hours of required courses over an eight semester period plus the summer field operations course.

The students participating in these programs can elect a cooperative educational arrangement as an option. Approximately three students participate each semester and the U.S. Environmental Protection Agency office in Philadelphia is the largest employer of Temple University's environmental students.

Although there are no specific departmental grants available to students as financial assistance, Pennsylvania has grants available entitled Pennsylvania Higher Education Agency and Basic Education Opportunity Grants and other forms of federal grants are available.

CURRENT FACULTY, STUDENTS, GRADUATES

Only two faculty professors are engaged in teaching Temple University's environmental courses offered in the two degree programs. However, other full-time faculty in other departments also teach major courses in noise control, solar energy, environmental impact assessment and energy and environment.

There are currently 64 full-time students (nine females) and twelve part-time students enrolled in the baccalaureate program. Eight students (3 females) are enrolled in the associate program. Approximately fifteen baccalaureate students and one to two associate degree students graduate annually. The baccalaureate program has been increasing steadily but not as rapidly as has been expected by program officials. Enrollment in the associate degree program has been low and appears to be declining.

Almost all of the associate degree students transfer into the baccalaureate program. However, only ten to fifteen percent of the Environmental Engineering Technology graduates continue for advanced degrees. Because of a state and city policy of hiring engineers and not technicians, few Temple graduates work for city or state environmental agencies. The U.S. EPA Regional Office in Philadelphia is a consistent employer of Temple graduates (2 each year). Recent graduates have also found employment with local water treatment equipment manufacturers and sales engineering firms (as technical representatives). Because the unavailability of public agency jobs in the Philadelphia area exists, eighty percent find private sector employment.

PROGRAM PROJECTIONS

Temple University plans to offer its first baccalaureate engineering degree program in the fall of 1978. Many of the environmental courses will be incorporated in the engineering curriculum. One day-adjunct instructor and six to seven evening adjuncts are expected to be recruited in the near future to teach energy and environment, air pollution, environmental impact preparation, and computer modelling courses. All will have engineering backgrounds and will teach specific courses on an adjunct basis. The Environmental Technology programs are acquiring a unit operations laboratory in a new building during 1978 and air/industrial hygiene will be taught in its facilities. The laboratory will be equipped with pilot scale water and wastewater treatment plants with capacities of between one-half to one million parts per million capacity.

As baccalaureate enrollment appears to be increasing steadily, a B.S. in Engineering Science with no departmental sponsor will be initiated. Ultimately an environmental engineering major will be developed, but no departmental degrees will be offered.

COURSE DESCRIPTION

10 Introduction to Environment - Evaluation of environmental conditions. (3 s.h.)

11 Energy & Environment - The effects of energy development and use on environmental quality. (3 s.h.)

13 Environmental Chemistry - Basic principles of chemistry and stoicheometry as they relate to environmental pollution measurements and chemical treatment. (3 s.h.)

17 Sanitary Chemistry & Microbiology - Wet analysis of environmental importance; sampling; data handling; standard test; microbiology. (3 s.h.)

24 Environmental Instrumentation - Optical, electrochemical and instrumental methods of analysis; environment applications. (3 s.h.)

31 Pollution Control Processes - Liquid and gas properties of importance in environmental control operations; sedimentation, filtration, membrane processes, adsorption, ion exchange, chemical treatment. (3 s.h.)

33 Environmental Field Operations - Field aspects of environmental engineering: Air and water sampling, stack sampling, bioassay and environmental aspects of planning. (4 s.h.)

110 Air Pollution Control Systems - Principles of design and operation of municipal and industrial wastewater treatment plants. (3 s.h.)

113 Solid Waste Management - Refuse collection and disposal incineration; landfill; composting; recycling; special wastes. (3 s.h.)

115 Water Treatment - Chemical and physical methods of treatment of water supplies. (3 s.h.)

116 Environmental Regulations - View of environmental regulations at the federal, state and local levels. (3 s.h.)

120 Environmental Systems Design - The practical design of pollution control systems in the areas of air, water, solid waste, industrial hygiene and noise. (3 s.h.)

210 Environmental Planning - Planning as a factor in minimization of environmental impact and on preparation of environmental impact statements. (3 s.h.)

211 Energy Resource Development - Current energy sources, available resources and methods of development. (3 s.h.)

390 Independent Study in Environmental - Student permitted to study a regular course on his own during the semesters the course is not offered, enabling student to meet prerequisite or graduation requirements. (2-4 s.h.)

398 Independent Research - Student will be assigned a research project with the approval of the department chairman and conducted under the supervision of a faculty sponsor. (2-4 s.h.)

INSTITUTION: TEXAS A & M UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) in Civil Engineering

CONTACT: Dr. Harold William Wolf
Professor, Civil Engineering
Texas A & M University
College Station, Texas 77843
(713) 845-3011

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering is an integral component of the Civil Engineering Department, College of Engineering, at Texas A & M University. The programs date back to the 1920s although substantial changes have occurred since that time. At Texas A & M, environmental engineering is a multidisciplinary program. These broad-based programs allow students to emphasize surface and groundwater quality, water resources, air quality control, and management of solid wastes. Close cooperation is maintained with other departments in order to insure the appropriate interfacing components of the overall program structure.

The university maintains modern and fully equipped laboratories. Within the civil engineering department, over 15,000 square feet of space is allocated to environmental engineering laboratories. Faculty and students also utilize the new waste treatment plant for research and instruction. The Division of Environmental Engineering operates a pilot treatment plant and a research laboratory at the new treatment plant site.

PROGRAM REQUIREMENTS

The requirements for the Master of Science degree (M.S.) include successful completion of at least 32 semester hours of academic course work past the baccalaureate degree, of which six may be in CE 691 (thesis). All students must complete a statistics or mathematics course from Stat. 601, Math. 411, 417 or 601. Additional requirements vary according to the particular concentration which may be: (a) water quality; (b) air quality; (c) solid waste management; or (d) environmental systems. Particular requirements include the following:

	(a) water	(b) air	(c) s.w.	(d) en.sys.
CE 406	x	x	x	x
CE 603	x	x	x	x
CE 604	x			x
CE 605	x	x	x	x
CE 607	x	x		x
CE 608		x	x	x
CE 610				
CE 611				
CE 680			x	
CE 681	x	x	x	x

In addition, water quality students must take six semester hours in two sciences (microbiology, organic chemistry, physical chemistry), and one course from CE 606, 610, or 611. Air quality and solid waste management students must take six semester hours in related technology or science areas other than environmental engineering. Environmental systems students must complete six semester hours in computing science or related mathematical modeling.

In order to qualify for the Ph.D., the student must have obtained the M.S. degree. Doctoral students are required to accomplish the following: (1) demonstration of competence in some form of computer language; (2) satisfaction of master's level course requirements; (3) completion of a minimum of 12 semester hours outside civil engineering; and, (4) completion of all special requirements as detailed by the Civil Engineering Department.

CURRENT FACULTY, STUDENTS, GRADUATES

The faculty currently associated with the Texas A & M environmental engineering graduate programs, consists of 15 personnel. These personnel also allocated part-time to other civil engineering programs. Responsibilities of these personnel include: 5.43 teaching; 8.93 teaching; and .63 administation.

The enrollment at present includes 15 full-time graduate students. There are 13 male and one female master's level students, and one male doctoral student. The enrollment, at present illustrates a slight increase in master's students, and a decrease in doctoral students since 1973.

Graduates of this program have also decreased slightly over the last few years. During the last academic year (1976-77) three students earned the Master of Science and two students were awarded the Doctor of Philosophy degree.

Approximately 2% - 3% of the master's students, annually elect to pursue the doctoral degree. Historically, these students have chosen Rice University and the University of Texas for their continued education.

PROGRAM PROJECTIONS

Growth in the faculty will include five additional Ph.D. personnel (microbiology, chemistry and biology) within the next two years. Enrollment growth is also anticipated.

COURSE DESCRIPTION

CE 603 Stream Quality - Physical, chemical, radiological and biological properties of streams, impoundments, reservoirs and estuaries and the interrelationships of these properties; local, state, regional and federal water quality standards. (3 s.h.)

CE 605 Experimental Analysis in Environmental Engineering - Theory and practice of analytical methods used in the environmental engineering field. (3 s.h.)

CE 606 Design of Wastewater Treatment Systems - Application of the theories of unit operations and unit processes to design wastewater treatment systems for domestic and industrial wastes. (3 s.h.)

CE 607 Environmental Analysis for Urban Areas - Analysis of urban problems, including air pollution and environmental engineering, problems affecting urban and suburban areas. (3 s.h.)

CE 608 Environmental Design for Urban Areas - Design of environmental engineering projects related to urban problems including air pollution. (3 s.h.)

CE 609 Simulation of Water Resources Systems for Numerical Analysis - Digital methods for simulating runoff from river basins. Numerical evaluation of stream quality variation. (3 s.h.)

CE 610 Industrial Wastes - Theory of industrial processes which create industrial wastes. (3 s.h.)

CE 611 Design of Potable and Industrial Water Systems - Application of theories of unit operations and unit processes to the design of systems for treatment of water for domestic and industrial uses. (3 s.h.)

CE 624 Environmental Effects of Transportation Systems - Interaction of traffic facilities with the adjacent land. (2 s.h.)

CE 626 Roadside Safety Design - Fundamental concepts of designing safety into roadways. (3 s.h.)

CE 627 Hydrology - Weather and hydrology, precipitation, streamflow analysis, subsurface water, streamflow hydrographs, streamflow routing, computer simulation of streamflow, probability studies, sedimentation. (3 s.h.)

CE 664 Water Resources Development - Planning and measurement concepts for control, conservation and utilization for water resources. (3 s.h.)

CE 681 Seminar - Reports and discussion of current research.
(1 s.h.)

INSTITUTION: THE COOPER UNION

PROGRAM: Integrated Master's Program in Engineering With Concentration
DEPARTMENT: in Environmental Engineering
School of Engineering
DEGREE:
Master of Engineering (M.E.)

CONTACT: Dr. John L. Bove
Professor of Chemistry and Environmental Engineering
The Cooper Union
Cooper Square
New York, New York 10003
(212) 254-6300

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The integrated engineering program at Cooper Union offers students a concentration in environmental engineering which is actually a minor in one of the four traditional engineering disciplines available: chemical, civil, electrical, and mechanical engineering. The integrated program was initiated in 1975. A unique feature of Cooper Union is that no tuition is charged. The School is supported by an endowment.

This program is five years in length and integrates work at both the undergraduate and graduate levels. Students are required to major in traditional engineering discipline and to elect a minor in a field substantially different from the major. Curricula is based on intense study in the sciences, mathematics, and interdisciplinary fundamentals of engineering. Upon completion of appropriate bachelor's degree requirements, a student receives the Bachelor of Engineering degree as well as the M.E.

Program support is provided by the laboratory facilities of the School of Engineering and the Institute for Energy and Environmental Management. This Institute conducts research on long-range problem solutions for industry and local governments.

PROGRAM REQUIREMENTS

Admission to the program requires a high school diploma with a minimum of sixteen units completed in the following summer: four units of English, two units of history and social studies, three and one-half units of mathematics, one unit of physics, one unit of chemistry, and four and one-half units of electives. In addition, applicants must take the Scholastic Aptitude Test along with achievement tests in physics or chemistry and math.

Degree requirements include a minimum of one hundred and seventy credits. The requirements in specific subject areas vary according to the major field of study. Each student is required, however, to take at least twenty-four credits in humanities and social studies, five credits in interdisciplinary engineering, and fifteen credits in the minor field of study. A thesis or project in the major or minor field of study, equivalent to a maximum of six credits, is also required.

Within the environmental engineering concentration, students are required to complete courses in environmental fundamentals, air pollution control systems, water resources engineering, and two advanced technical courses of their choosing.

CURRENT FACULTY, STUDENTS, GRADUATES

Program faculty consists of ten part-time members and another ten adjunct members who are also involved on a part-time basis. Their primary function is teaching and although no credit is given for research, all do environmental research through the Cooper Union Research Institute. Research has been funded by the City of New York, EPA, and private sources.

Because the program and the environmental concentration began in 1975, students will be selecting their minor concentrations during the current school year. Officials estimate that about twenty-five to thirty students will elect environmental engineering. Approximately eighty percent of the students come from the New York City area with most of the remainder coming from New York State and New Jersey. No recruitment is done for the program since there are always more applicants than can be accepted. Student financial assistance is not a major consideration since there is no tuition charge. Until 1977 the program did, however, receive an EPA training grant.

Although no specific information is available on program graduates, officials indicated that about twenty-five graduates each year are anticipated. Of current engineering graduates, approximately seventy-five percent work in the private sector and the remainder in government agencies. Placement is generally done by the school's placement office.

PROGRAM PROJECTIONS

A curriculum study is currently being conducted within the School of Engineering on the feasibility of integrating humanities into the engineering program. No changes are anticipated prior to completion of this study in 1979.

COURSE DESCRIPTION (SELECTED)

EID 140 Environmental Fundamentals - The nature of the environment-air, water, land and solar radiation interrelationships. Demographic trend, material and energy demands and the environment. Sources of environmental pollution and legal activities toward their control. Factors affecting pollutant levels in the atmosphere. (3 s.h.)

EID 141 Air Pollution Control Systems - System design for particulate, gas and vapor recovery. Study of dynamics of particulate behavior in fluid stream, Brownian motion, interception, inertial impact; target geometry and effects; nucleation and particle growth; energy consumption and collection efficiency. Other topics. (3 s.h.)

EID 142 Water Resources Engineering - Problems in conservation and utilization of water. Hydrologic techniques. Surface water and ground water supplies. Water transmission and distribution. Problems of water pollution, groundwater flow, and drainage. (3 s.h.)

EID 341 Environmental Impact Analysis - The purpose, contents, and resulting actions of an environmental impact statement (EIS). Consideration will be given to the proper protocol for preparing an EIS. Some time will be spent reviewing the role of the U.S. EPA in the evaluation of the EIS, and some of the recent trends associated with state and local government roles. (3 s.h.)

EID 342 Environmental Modeling and Simulation - Consideration of various modeling methodologies including: rollback, black box models, k-theory, similarity theory; other topics of current interest. (3 s.h.)

EID 343 Air Pollution Instrumentation and Measurement - This course covers operation and calibration of monitors for particulate and gaseous air pollutants, analysis of fuel oil samples for sulfur content, analysis of gasoline samples for lead content and vapor pressure. (3 s.h.)

EID 344 Environmental Law and Planning - A survey of legislative, administrative and judicial controls that affect the engineer and scientist in relation to air, water and other forms of pollution abatement and control. (3 s.h.)

EID 443 Hydrology - Hydrology of the water cycle related to air mass movement, precipitation, evaporation, and other topics. (3 s.h.)

INSTITUTION: THE PENNSYLVANIA STATE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Master of Engineering in Environmental Engineering (M.E.E.E.)
Doctor of Philosophy in Environmental Engineering (Ph.D.)

CONTACT: Dr. Raymond E. Untraver, Head
Department of Civil Engineering
212 Sackett Building
The Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-8391

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Engineering Program at Penn State was first initiated in September, 1972. It is really an expansion of the Bachelor of Science degree in Sanitary Engineering, a program first started in 1908. At the undergraduate level, the program is designed to provide a basic foundation in engineering supplemented by specialized study in the areas of air, water and solid waste, and radiological protection. All students in the program will receive instruction in one of them by selecting an option for his or her last four terms. A general option is available for those students who wish to postpone specialization to a graduate level program. The major is an interdisciplinary one within the College of Engineering and it is administered by the Department of Civil Engineering. Continuous liaison is maintained with the College of Earth and Mineral Sciences.

The Environmental Engineering degrees at the graduate level are administered entirely by the Civil Engineering Department. The graduate program can also provide specialization in the areas of air, water, or solid waste.

Most students obtain employment with consulting engineering firms, regulatory agencies and industry.

Extensive laboratory facilities are provided for Environmental Engineering in the departments of the two colleges involved with research and instruction. The Department of Civil Engineering has laboratory facilities for instruction and research in the areas of water, wastewater and solid waste. The Department of Mechanical Engineering has laboratories in the area of air pollution control. Additional research and laboratory space is available in the Center for Air Environment

Studies. The Department of Nuclear Engineering operates the Breazeale Nuclear Reactor with laboratory facilities in the area of radiological protection. Facilities are avsilable in the College of Earth and Mineral Science laboratory in the areas of geochemistry, hydrogeology, and mineral processing.

PROGRAM REQUIREMENTS

Candidates with a baccalaureate degree in a field of engineering are eligible for the advanced degrees. The degree should be from an institution accredited by the Engineer's Council for Professional Development. In order to enter the College of Engineering as an undergraduate, three units of English, three units of mathematics (1½ units of algebra, 1 unit of plane geometry, and ½ unit of trigonometry), one unit of science, and eight other units are required during high school preparation.

For the B.S. degree in Environmental Engineering, 140-143 credits are required, depending on the option selected. Required are 67-68 baccalaureate degree requirements, 51 credits of major requirements and 22-24 credits for the option (general, 22; air, 22; radiological, 24; and water and solid waste, 23).

Requirements for the Master of Science degree in Environmental Engineering include 30 semester credits of course work (20 to be completed in residence), a thesis, and a twelve month completion period. No language proficiency is required.

The Master of Engineering degree in Environmental Engineering requires completion of 30 credits in residence with 27 credits in course work and 3 credits directed to the Engineering Report.

The Doctor of Philosophy degree in Environmental Engineering requires completion of a candidacy exam, language exam, comprehensive exam, dissertation, and final oral exam.

A five-year work study program in environmental engineering is available and includes alternating periods of study and employment. Two years of engineering experiences and money to offset educational costs are acquired by students admitted to this program.

At the graduate level, one and one half departmental graduate assistantships are available. Sponsored research projects are the funding sources for additional assistantships.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten full-time faculty members make up the interdisciplinary faculty which teach the undergraduate level courses. Eight are from Civil Engineering (5 water quality; 3 water resources hydrology); one is from Mechanical Engineering (air pollution); and one is from the Nuclear Engineering Department (radiation). Six professors from the

Department of Civil Engineering make up the graduate Environmental Engineering staff. They devote about 70 percent of their time to teaching and 30 percent to research activities. Most research funding is from industry although the City of Philadelphia does provide some funding for research.

There are currently (Fall, 1977) a total of 130 (12-15 female) full-time students enrolled in the undergraduate program. Included are two to three part-time co-op students. At the graduate level, 19 students (1 female) are enrolled in advanced degree programs. An average of 23 undergraduates and eight graduates annually earn degrees from the Environmental Engineering program.

Approximately 20-25 percent of the undergraduates continue on for advanced degrees. Most master's students continue on to other educational institutions for doctorates. In previous years, most (60 percent) of the master's students were continuing on for doctorates at Penn State. Eighty percent of the program's graduates have obtained employment in their field and 70 percent have found jobs in the private sector, mostly with consulting engineering firms. Consulting engineering firms make an active recruitment effort of Penn State students. Only 30 percent of the program's graduates have found positions in government agencies.

PROGRAM PROJECTIONS

The Environmental Engineering Program is now at maximum capacity and little additional growth is projected. No change from the current emphasis is expected. During the last two to three years, the enrollment has increased greater than what was anticipated. Financial constraints prevent the hiring of any additional staff members for the program.

COURSE DESCRIPTION (SELECTED)

Biol 410 General Limnology - Organisms found in inland waters; biological factors affecting their distribution and relationship; intensive studies of our local streams. (3 s.h.)

Biol 435 Ecology of Lakes and Streams - Physical, chemical, and biological characteristics of freshwater environments, with special emphasis on factors regulating productivity in freshwater ecosystems. (3 s.h.)

Bio 481 Aquatic Botany - Identification, collections, and relationships of higher aquatic plant groups; field study of habits. (3 s.h.)

CE 51 Engineering Hydrology - Water sources and losses in nature; effects of precipitation, evaporation, and subsurface percolation on streamflows; flood prediction, water resource management.(2 s.h.)

CE 70 Water Pollution Control -Quantity and quality of municipal and industrial water and waterwater. Unit operations and treatment processes for water pollution control. (3 s.h.)

CE 371 Water and Wastewater Transport Systems - Water storage and transmission; design of water distribution and sewerage systems; pumps and pumping systems. (2 s.h.)

CE 451 Advanced Hydrology - Recent advanced in deterministic, stochastic, and urban hydrology. (3 s.h.)

CE 471 Environmental Sanitation - Public health engineering applications related to communicable diseases, water supply, wastewater disposal, solid wastes, air pollution, food, vectors, and radiation. (3 s.h.)

CE 472 Water Pollution Control Processes - Principles and design of unit operations for water; domestic and industrial wastewater treatment; equipment selection and application. (3 s.h.)

CE 473 Water Quality Management - Water quality criteria and standards; fate and impact of pollutants in aquatic systems; technology available for wastewater renovation. (3 s.h.)

CE 476 Solid Waste Management - Solid waste collection, salvage and disposal techniques for municipalities and industries; cost analyses; legislation; management; financing; design optimization. (3 s.h.)

CE 570 Physical Chemical Treatment Processes I - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (2 s.h.)

CE 571 Physical Chemical Treatment Processes II - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (3 s.h.)

CE 572 Biological Treatment Processes - The theory of biological processes used in the treatment of municipal and industrial wastewaterss. (3 s.h.)

CE 574 Laboratory Analyses in Water Quality Control - Experiments illustrating current chemical and biochemical methods of water and waste treatment and analytical methods used in research and control. (3 s.h.)

CE 575 Industrial Waste Treatment - Surveys and data analysis; use of unit processes to meet regulatory agency requirements; disposal of gaseous and solid residues. (2 s.h.)

CE 577 Treatment Plant Design - Design of works for the treatment of water and wastewater for municipalities and industries. (1-6 s.h.)

CE 579 Aquatic Microbiology - Ecology and physiology of microorganisms of inland waters, estuaries, and oceans; microbiology of wastewater treatment. (3 s.h.)

CE 580 Stream and Estuarine Analysis - Quantitative assessment of advection, reaction, and dispersion processes in polluted waters; reaeration theory; eutrophic systems; analog simulation. (3 s.h.)

FS 430 Air Pollutants from Combustion Sources - Generation of pollutants in combustion chambers; reduction by combustion control; pre- and post-combustion treatment of fuels and effluents.

HPA 420 Environmental Health - Identification, evaluation and control of environmental hazards. Biological and social considerations of the interaction of human populations with their physical environment. (3-6 s.h.)

ME 58 Acoustics and Noise Control - Sources, measurement, description of environmental noise, transmission loss, noise reduction at source by absorption, isolators and mufflers, noise measurement exercises. (3 s.h.)

ME 458 Noise Control in Machinery - Nature of noise sources in machine elements and systems. Propagation and reduction of noise. (3 s.h.)

METAL 460 Pollution Control in the Mineral Process Industries - Recycle, utilization and pollution control of air, water, and solid wastes from mineral processing plants. Pollution control through process modification. (3 s.h.)

METEO 310 Introduction to Atmosphere Science - Survey of atmospheric processes and analytical methods of atmospheric science. (3 s.h.)

METEO 452 Hydrodynamics of the Atmosphere - Equations of motion; circulation and vorticity; elements of turbulence theory and perturbation theory; introduction to numerical weather prediction. (3 s.h.)

METEO 453 Atmospheric Thermodynamics - Thermodynamic properties of the atmosphere with emphasis on water vapor; applications to forecasting problems. (3 s.h.)

METEO 475 Chemistry of the Atmosphere - Chemical properties of atmospheric components and contaminants. Dispersion and removal processes in connection with cloud physics, circulation, and air pollution. (3 s.h.)

MICRB 400 Introductory Environmental Microbiology - Elementary ecological relationships of microorganisms in the biosphere; role of bacteria in water pollution and purification. (2 s.h.)

MN EC 484 Political Economy of Energy and the Environment - Energy-its nature, use, markets and environmental impacts. (3 s.h.)

MNG 400 Mining and our Environment - For nonmining students. Nontechnical treatment of mining methods, practices, and role in today's civilization; socioeconomic and environmental problems. (3 s.h.)

NUC E 428 Radioactive Waste Control - Nature, sources, and control of radioactive wastes; theory and practice of disposal processes. (3 s.h.)

INSTITUTION: THE PENNSYLVANIA STATE UNIVERSITY

PROGRAM: Environmental Pollution Control

DEPARTMENT: Intercollege

DEGREE: Master of Science (M.S.); Master in Environmental Pollution Control (MEPC); Master of Engineering (ME)

CONTACT: Dr. John B. Nesbitt
Charge of Graduate Programs in Environmental Pollution Control
226 Merrell R. Fenske Laboratory
Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-1226

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

First initiated in 1971, the Environmental Pollution Control Program is an intercollege program dealing with various aspects of the control of air and water pollution and the disposal of solid wastes. Options are available in: Air Environment; Basic Physical and Biological Sciences; Environmental Health; Environmental Resource Management; Land Environment; Mathematics, Statistics, and Computer-Science; Noise; Planning; Pollutant Control in Industrial Processes; Radiological Protection; Systems Analysis; Water Resources - Quantity; and Water Resources Quality. An interdisciplinary faculty committee and participating departments provide graduate instruction. Other graduate faculty members other than those in the committee have a teaching and/or research interest in the area of environmental pollution control. Graduates are prepared to enter positions with consulting engineering firms, state, local, and federal regulatory agencies, and in private industry. Many have found positions with the Pennsylvania Department of Environmental Regulation and the Department of Transportation. Some have found employment with the U.S. Geologic Survey and EPA, for example. They have served in the capacities of operation plant inspectors, water or air pollution control specialists (not engineers), engineering assistants or technicians,and have prepared environmental impact assessments for consultants.

Research facilities utilized by the program's students are those maintained by the various participating departments at the University. There are none specifically designated for the Environmental Pollution Control Program. Research work conducted by students are sponsored by the various departments associated with the program.

PROGRAM REQUIREMENTS

Admission into the program is granted upon the recommendation of the head of the academic department in which the student plans to complete a program and the environmental pollution control program faculty committee. Mathematics through integral calculus, and one year of work in both general physics and chemistry is normally required for admission. Considered for admission are students with appropriate backgrounds in mathematics and science and a 2.75 junior-senior average.

Students enrolled in the Environmental Pollution Control Program are required to pass 9 credits of EPC core courses and 3 credits of EPC 590 seminars. One credit of the seminar in air is given during the fall term, one in water is given during the winter term, and one credit in solid waste management is offered during the spring. The core courses are: CE 472, Water Pollution Control Processes; CE 476, Solid Waste Management; and ME 470, Fundamentals of Air Pollution. Students not choosing to major in Water Pollution Control may substitute CE 473, Water Quality Management for CE 472, Water Pollution Control Processes.

In addition to the 12 credits of core courses and seminars,a minimum of 12 of the remaining 18 credits required for the master's degree must be selected from the EPC recommended courses list.

Master of Environmental Pollution Control: at least 9 of the student's total credits must be at the 500 level and these 9 credits should not include EPC seminars or credits taken to write the MEPC paper.

Master of Science in Environmental Pollution Control: at least 18 credits at the 500 and 600 level and these may include the EPC Seminars; and for most departments a thesis must be written.

Students can develop, with the help of an advisor in the selected department of affiliation, a program that will specialize in one area yet provide a basic comprehension of the problems encountered in other areas of environmental pollution control. The proposed program study, approved and signed by the student's advisor, is normally submitted to the program office within the first three weeks.

The student advisor, the head of the department of affiliation, and the EPC Program Chairman, determine the requirements concerning the research paper or thesis.

The university provides eight terms (2 years) of financial assistance to graduate assistants. Additional graduate assistance is provided through the student's departmental affiliation and usually involves work on funded research projects.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of forty faculty members contribute to the offering of the courses in the program. Thirty-three faculty are senior graduate faculty members and seven are associate graduate faculty members. They devote about 70 percent of their time to teaching activities and 30 percent to research.

There is a total of 26 full-time students enrolled in the Environmental Pollution Control Program. All except one student are male and there is only one part-time student in the program. About one-half of the students are affiliated with the Civil Engineering Department and the rest are from Agronomy, Veterinary Science, Mining Engineering, Geography, Meterology, Food Science, and Biological Health. Ten to fifteen students have graduated annually in recent years and the four-year average is 14 students. Enrollment and the number of graduates have remained relatively stable over the past couple of years.

The Environmental Pollution Control Program is designed to be a terminal Master's program. Resumes of students enrolled in the program and the Center for Air Environmental Studies are published and mailed to prospective employers. This has resulted in rather successful placement of graduates. About 95 percent of graduates find employment in their field and the rest are unknown. Approximately 30 percent find positions in governmental agencies, 40 to 50 percent in the private sector, and 20 percent in academia and other areas. Most finding positions with the Pennsylvania Department of Environmental Regulation serve as operations plant inspectors, conducting stream surveys, water or air pollution control specialists. Those finding positions with consulting firms are employed as engineering assistants or technicians, prepare 208 Areawide Planning Studies, prepare environmental impact assessments, and in sales. Some graduates take further fluid mechanics or waste treatment courses and thus obtain engineering work with consulting firms.

PROGRAM PROJECTIONS

Because of time and fiscal constraints, no change is expected to develop with the Environmental Pollution Control Program. The present orientation of the program is considered to be adequate in structure and no additional faculty members are expected to be recruited. There appears to be a leveling off of enrollment in the program to 25 to 30 per year.

COURSE DESCRIPTION

(the following is a partial listing of courses)

CE:

451 Advanced Hydrology - Recent advanced in deterministic, stochastic, and urban hydrology. (3 s.h.)

472 Water Pollution Control Processes - Principles and design of unit operations for water; domestic and industrial wastewater treatment; equipment selection and application. (3 s.h.)

474 Management of Water Pollution Control Processes - Personnel requirements, record systems, unit process operation and control, laboratory control and equipment maintenance systems. (3 s.h.)

476 Solid Waste Management - Solid waste collection, salvage and disposal techniques for municipalities and industries; cost analyses; legislation; management; financing; design optimization. (3 s.h.)

554 Urban Hydrology - Several hydrograph methods. Design storm and IUH application; airport drainage; flood plains; impact of urbanization upon groundwater and sediment. (3 s.h.)

570 & 571 Physical Chemical Treatment Processes I & II - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (2-3 s.h.)

573 Problems in Environmental Pollution Control - Investigations, analyses, and reports on current topics in environmental pollution control. (3 s.h.)

575 Industrial Waste Treatment - Surveys and data analysis; use of unit processes to meet regulatory agency requirements; disposal of gaseous and solid residues. (2 s.h.)

Mechanical Engineering

405 Air Pollution Control Systems - Small particles formation, properties, and behavior; equipment design and instrumentation; air pollution control, atomization, mass transfer, filtration. (3 s.h.)

458 Noise Control in Machinery - Nature of noise sources in machine elements and systems. Propagation and reduction of noise. (3 s.h.)

470 Fundamentals of Air Pollution - Nature, sources, transport, control, and effects of pollutants; sampling methods; air quality criteria and standards, economics, and planning. (3 s.h.)

Microbiology

400 Introductory Environmental Microbiology - Elementary ecological relationships of microorganisms in the biosphere; role of bacteria in water pollution and purification. (2 s.h.)

INSTITUTION: UNIVERSITY OF ALABAMA

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Engineering (Environmental Engineering)
Master of Science in Civil Engineering
Master of Science in Engineering Hydrology

CONTACT: Dr. George P. Whittle, Chairman
Environmental Engineering Committee
Department of Civil and Mineral Engineering
Box 1468
University, Alabama 35486
(205) 348-6550

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The formalized environmental engineering graduate program at the University of Alabama began in 1970 under a three-year training grant from the Environmental Protection Agency. The grant provided support for approximately four trainees per academic year; thirteen students received support during the grant period. The program was set up so that students from non-engineering as well as engineering disciplines could pursue graduate work in environmental engineering. This interdisciplinary program has been offered chiefly under the degree curriculums listed above.

The primary goal of the program is to provide training for those students in engineering and science who, in their graduate work toward a master's degree, wish to relate their specific fields to the areas of environmental pollution abatement and control. The training grant period served as a foundation for the currently offered degree programs. The program has grown stronger with regard to student population, faculty, courses and facilities.

Environmental engineering faculty have conducted short courses for utilities and governmental agencies, and participate in other related events such as coastal engineering conferences. They also have assisted with short courses offered annually to treatment plant operators, in cooperation with the Alabama Water and Pollution Control Association.

Environmental and energy-related research carry a high priority in the department, which receives research funds from a variety of governmental agencies, as well as private concerns. Between 1970 and 1977, a total of approximately one million dollars was received for research projects. Areas under study have included water treatment, stream analysis, water quality modeling, underground waste injection, coal mining pollution, and earth resource user identification, using data from orbiting satellites.

PROGRAM REQUIREMENTS

Students holding bachelor's degrees from engineering curriculums accredited by the Engineers' Council for Professional Development are eligible for acceptance into the program, as are students with degrees in the mathematical and physical sciences. The latter include, but are not limited to the disciplines of biology, chemistry, mathematics, physics, and geology.

To enter the M.S. in Civil Engineering program and major in environmental engineering, students must have forty-two credit hours of specified prerequisites. The required courses are in the fields of chemistry, mathematics (through differential equations), mechanical engineering (statics, particle dynamics, fluid mechanics and mechanics of materials) and civil engineering (sanitary engineering, wastewater disposal, and fluid mechanics). Students in this curriculum have a choice of two plans. Under Plan I, twelve hours of graduate courses in the major field, six hours in a minor field, six hours of electives, six hours of mathematics beyond differential equations, and a thesis are completed. Students selecting Plan II must complete eighteen hours in the major field, six hours in a minor field, nine hours of electives, and six hours of mathematics beyond differential equations.

Prerequisites for the M.S. in Engineering (Environmental Engineering) curriculum are similar to the above, except that courses in the mechanics of materials are not required. Students in this program also have two options, Plan I and Plan II, similar in structure and requirements to the above with the exception that the six hours of mathematics beyond differential equations are not required. In addition, at least six of the hours required in the major field must be numbered six hundred or above; they must include one course in air pollution and one course in water pollution. Two seminars are required.

The M.S. in Engineering Hydrology is open to all college graduates who have completed at least one semester's work each in chemistry and physics, mathematics through differential equations, and an engineering mechanics sequence through fluid mechanics. The program draws largely on courses offered by the Departments of Civil and Mineral Engineering, and Geology, with the collaboration of the Geological Survey of Alabama and the U.S. Geological Survey. The required course work is planned to meet the needs and interests of the student, and may be selected from many areas within the engineering hydrology program.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight faculty members in the department participate, through teaching and research, in the environmental engineering program, although several other faculty members support the program to a lesser degree. There are sixteen students currently in environmental engineering. Six of these are seeking to obtain the M.S. in Civil Engineering, while the remainder are in the M.S. in Engineering (Environmental Engineering) program. A number of these students receive financial support from teaching assistantships, research grants or university-sponsored fellowships. Many, however, support themselves with part-time jobs.

During the years 1973 to 1976, two to three graduates were being produced per year. Presently, three to four complete an environmental engineering curriculum annually. Officials have followed up on graduates, and found that every graduate has been able to secure employment in the environmental field. Approximately 70 percent of these go to the private sector, the remainder to governmental agencies.

PROGRAM PROJECTIONS

Program sources believe that the enrollment will continue to grow in environmental engineering; within two years it is estimated that five persons will be graduating annually. Also forecasted is continued strength in teaching, research and service. These projections are based, in part, on documented past growth, and on efforts under way by faculty members. For example, discussions have been initiated with the Biology Department concerning elective course work available to both the biology and the environmental students in the respective departments. As a result, a new interdisciplinary M.S. degree in Biology (Aquatic Biology) may be developed. Faculty would also like to develop an interdisciplinary undergraduate program in environmental engineering. At present, however, it is very difficult to establish new degree programs within the university.

The rate of program growth and forecast fulfillment is dependent upon many factors, among which the financial support of graduate students is considered the most significant. Solicitations will continue for training grants, fellowships, and research projects.

COURSE DESCRIPTION

Partial listing of approved courses:*

CE 420 Sanitary Engineering Science - Atomic and molecular structure. Solution chemistry. Thermodynamics, reaction kinetics. Biological principles. Water supply development, water treatment and distribution. (3 s.h.)

CE 424 Wastewater Disposal - Biological and chemical principles of wastewater treatment systems and treated effluent disposal. Wastewater and storm flow collection systems. (2 s.h.)

CE 429 Environmental Science and Engineering - Principles of chemistry, physics, biology, and bacteriology applied to man's environment. Engineering, economic and social problems of air and water pollution resulting from man's activities. (3 s.h.)

CE 475 Hydrology - Factors governing the supply of ground water and the flow of streams and their relation to water power, water supply, drainage, and sanitary work. (3 s.h.)

CE 521 Industrial Hygiene - Environment in relation to health and work performance, emphasizing engineering control. (3 s.h.)

CE 522 Aquatic Biology for Engineers - Biology of natural streams and biological aspects of water quality. (3 s.h.)

CE 523 Water Treatment - The theory and practice of chemical and physical methods of water examination and treatment. (3 s.h.)

CE 525 Water Treatment Laboratory - Procedures used for the evaluation and control of water quality treatment processes. (1 s.h.)

CE 527 Water Supply Engineering - Water supply purification and distribution. General design of water supply systems and treatment plants. (3 s.h.)

CE 528 Wastewater Systems - Principles of sewage collection and treatment, design of sewerage systems and treatment plants. (3 s.h.)

CE 623 Water Treatment Processes - Recent developments in the chemical and physical treatment of water for municipal and industrial uses. (3 s.h.)

CE 624 Industrial Water Treatment - Quality requirements for specific industrial water supplies and design of pertinent treatment systems. (3 s.h.)

CE 625 Water Quality - Water quality criteria. Theory and practice of water analysis. (4 s.h.)

CE 626 Radiation Problems - Environmental radiation hazards. Sources and effects of radiation exposure. Evaluation and control of radiation hazards. (3 s.h.)

CE 628 Industrial Waste Treatment - Evaluation of industrial wastes relating the character and quality of wastes to design of treatment processes for satisfactory disposal of liquid wastes. (3 s.h.)

CE 621 Air Pollution Control - Sources and characteristics of air pollutants. Air quality management methods. (3 s.h.)

CHE 465 Atmospheric Pollution -Atmospheric pollution and control. Nature of pollutants including gases, dusts, vapors, and fumes; atmospheric dispersal; methods of analysis and administration; and standards and control of air pollution. (3 s.h.)

CHE 489 Air Pollution Control Systems Design - Applications of chemical engineering to collection of particulate matter and to removal of particulate matter and to removal of noxious gases. Cyclones, scrubbers, precipitators, absorbers, and reactors. (3 s.h.)

*Environmental courses in biology, marine science and chemistry are also approved, and courses in computer science and statistics may be incorporated into the curriculum. Course work in other areas may be approved upon petition of the committee.

INSTITUTION: UNIVERSITY OF ALASKA

PROGRAM: Environmental Quality Engineering

DEPARTMENT: School of Engineering

DEGREE: Master of Science (M.S.) in Environmental Quality Engineering

CONTACT: Dr. John L. Burdick
Acting Department Head
Environmental Quality Engineering and Science
University of Alaska
Fairbanks, Alaska 99801
(907) 479-7241

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Master of Science in environmental quality engineering was established at the University of Alaska in 1970. Course work emphasizes the biological, physical and chemical sciences as an academic base. In depth consideration is given to the environmental problems and solutions which relate to current and future developmental projects in arctic and subarctic climates.

Students may consider concentrations of study which include solid waste management, protection and treatment of water and wastewater and air quality control with emphasis on cold climates.

The University of Alaska is located in the subarctic of Interior Alaska. Due to this unique location, students and faculty have access to glaciers, permafrost areas and oceans. Situated in the nation's largest single wilderness area, the university is able to conduct controlled studies involving man's effects upon the environment. The University, therefore, has several research units, on and off campus, such as the Institute of Arctic Biology, the Arctic Environmental Information and Data Center, and the Institute of Water Resources. At the Institute of Water Resources, students and faculty, from the environmental quality engineering program, as well as from other programs and departments, are able to work on problems relating to the water resources of Alaska.

Although not affilitated with the University of Alaska, the Arctic Environmental Research Laboratory (AERL) is situated on the Fairbanks campus and is a part of the growing arctic research activities. The AERL is a multi-million-dollar U.S. Environmental Protection Agency research laboratory.

PROGRAM REQUIREMENTS

The requirements for the M.S. degree in environmental quality engineering include completion of 30 semester hours of credit composed of 18 credits of required courses, six credits of electives, and six credits of thesis study. Required courses include: EQE 601, 602, 603, 604, 605, and 606. Elective courses include EQE 692, 693, 694, and 697.

At present there is no internship program or applied study term associated with the environmental quality engineering program. There is limited financial assistance available to students.

CURRENT FACULTY, STUDENTS, GRADUATES

Current faculty includes two full-time teaching members. The student enrollment totals 12. Full-time students include two males and one female. Part-time students include eight males and one female. Usually, this program does not attract career-change students.

The number of per annum graduates has decreased over the last few years from six in 1975 to two in 1977. Graduates gain employment in the public and private sector about equally. Historically, graduates of this program choose a career path rather than continued educational pursuits.

PROGRAM PROJECTIONS

The faculty of environmental quality engineering look forward to moderate growth and expansion during the next few years. Although the student enrollment is forecast to increase somewhat, the faculty does not anticipate either increase or decrease over the next three years. Substantive changes in the program format are also not likely in the near future.

The construction of the Trans-Alaskan-Pipeline has served to increase public awareness of the necessity for maximum control and protection of Alaska's natural resources. Thus, actions involving the pipeline as well as the Alaska Native Land Claims Settlement may have an eventual impact upon the growth of the University of Alaska program.

COURSE DESCRIPTION

EQE 601 Environmental Quality Science Measurements - Theory and laboratory procedures for determining quality of water supplies. Natural water quality, pollution loads and water and wastewater treatment plant parameters. Familiarization with Standard Methods for the Examination of Water and Wastewater. Experiments on unit processes of treatment systems are included along with consideration for solid waste and air pollution monitoring. (3 s.h.)

EQE 602 Engineering Management of Water Quality - Concepts, rationale, theory, institutions and engineering aspects of water quality management. Methods of water quality management; low flow augmentation, in-stream aeration; stream and estaurine analysis; ocean disposal systems; diffuser analysis and design, control of thermal effluents, industrial discharges and arctic applications. (3 s.h.)

EQE 603 Solid Waste and Air Pollution - Planning, collecting and disposing of refuse. Techniques of open dumping, land filling, sanitary land filling, composting, incineration, and resource recovery. Solid Waste environmental relationships to water, air and land pollution. Economics and case studies are included. Air pollution topics will include quantity and quality of atmospheric emissions and their effects on man and his environment. Identification and location of sources, measurement of quality and standards. (3 s.h.)

EQE 604 Environmental Quality Evaluation - Topics of environmental impact statements; environmental law (local, state and federal); and environmental quality. Impact from projects of mining, highways, airports, pipelines, industrial development, water, wastewater and solid waste, and other-theoretical considerations and case studies.

EQE 605 Chemical and Physical Water and Wastewater Treatment - The theory and design of chemical and physical unit process utilizing the treatment of water and wastewater. Sedimentation and flotation, ion exchange, absorption, coagulation, precipitation, filtration, disinfection, reverse osmosis and aeration theories will be studied. Design problems for all unit processes. (3 s.h.)

EQE 606 Biological Treatment Processes - Study of the theoretical and applied aspects of wastewater treatment by biological processes including activated sludge, trickling filters, lagoons, sludge digestion and processing, septic tanks; analysis and design; nutrient removal processes, biology of polluted water, economics, state and federal regulations. (3 s.h.)

EQE 692 Seminar

EQE 693, 694 Special Topics - (0-3 s.h.)

EQE 697 Individual Study - (0-6 s.h.)

EQE 699 Thesis - (0-6 s.h.)

INSTITUTION: UNIVERSITY OF ARKANSAS (Fayetteville)

PROGRAM: Agricultural Engineering

DEPARTMENT: Agricultural Engineering

DEGREE: B.S. in Agricultural Engineering
M.S. in Agricultural Engineering
Ph.D. (coursework emphasizes Agricultural Engineering)

CONTACT: Dr. C. Roland Mote
Department of Agricultural Engineering
University of Arkansas
Fayetteville, Arkansas 72701
(501) 575-2351

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Agricultural Engineering is the application of engineering principles to the problems of agriculture; and the University of Arkansas offers undergraduate and graduate degree programs in this area at the Fayetteville campus. The program prepares students for a wide variety of positions in the design, development, and sale of agricultural machinery and equipment; for design and construction of soil and water control systems for public and private organizations; for design, advisory, and management positions with agricultural buildings and building-materials manufacturers and suppliers; for design and management positions with feed and food processing organizations; for engineering electricity in agriculture; and for teaching, research, and service with public and private agencies, institutions, and manufacturers.

Areas of concentration at the master's and Ph.D. levels and technical options during the junior and senior undergraduate years include crop and food processing, agricultural waste management engineering, soil and water engineering, agricultural power and machinery, agricultural structures, and electrical power in agriculture. The Agricultural Engineering Department also offers courses intended for degree programs for students majoring in other departments in the College of Agriculture and Home Economics (See Course Description).

The generalized nature of the Agricultural Engineering program permits continual modification of the students' training to meet changing occupational needs and interests. Research is considered an integral part of the program. Facilities include those of the College of Agriculture and Home Economics, the Engineering Experiment Station, and the university in general. Research funding currently totals $450,000 with $8,767 from the Environmental Protection Agency; $5,000 from the Office of Water Resource Technology; and the remaining allocation from formula funding under the Hatch Act.

PROGRAM REQUIREMENTS

The B.S. degree in Agricultural Engineering is granted after successful completion of the 132 semester hours prescribed in the curriculum. (This curriculum is under the joint supervision of the deans of the College of Engineering and College of Agriculture and Home Economics, but the degree is awarded by the College of Engineering.)

Candidates for the M.S. degree must complete a minimum of thirty semester hours. A minimum of twelve semester hours must be taken in the major department exclusive of a thesis, a minimum of eighteen hours must be taken in engineering, and the remaining hours may be taken in related fields. A thesis may be written or additional classwork may be substituted for the thesis subject to approval of the major professor and graduate school dean. General requirements for the Ph.D. are the completion of thirty semester hours beyond minimum requirements for a master's degree and the reading knowledge of a recommended foreign language or six semester hours in a related field consistent with the student's goals and program of study.

CURRENT FACULTY, STUDENTS, GRADUATES

There are eleven full-time faculty members in the Department of Agricultural Engineering with the equivalent of 3.0 lines for teaching and 8.0 lines for research. These staff members serve 57 undergraduate majors, three M.S. students, and two Ph.D. candidates (the first in the program). Approximately five B.S. and two M.S. diplomas are awarded annually, and the number at the undergraduate level should increase in the next few years. There have been, of course, no Ph.D. degrees conferred to date in this program. About 95 percent of the Agricultural Engineering graduates gain employment in their field with the remaining students taking engineering-related positions. The ratio of jobs taken in the private sector to the public sector is 50:50; graduates are typically employed as consultants, researchers, and extension specialists and in design, manufacturing, sales, etc. Sources of financial support include assistantships, scholarships, and work-study.

PROGRAM PROJECTIONS

The future for the Agricultural Engineering program at the University of Arkansas is bright, especially because of its close relationship with the production of food fiber. The continued growth of the department may necessitate the addition of another full-time faculty member with attendant laboratory and assistant support personnel. A new degree in food processing is in the discussion stage at Fayetteville, but no other major curriculum changes are expected.

COURSE DESCRIPTION *

Departmental courses for majors in Agricultural Engineering:

1012 Agricultural Engineering Design Fundamentals - Acquaints the student with the role and scope of the professional agricultural engineer. Basic engineering methodology including computation procedures is introduced and demonstrated by the application of fundamentals to specific agricultural engineering design and analysis problems. (2 s.h.)

3713 Engineering Properties of Agricultural Methods - The physical properties of farm products, agricultural chemicals and soils as utilized in the design of agricultural production and processing equipment, storage structures, and materials-handling systems. Methods of laboratory determination and an introduction to research techniques. (3 s.h.)

4404 Design of Structures for Agriculture - Environmental, functional, and structural requirements of buildings for agricultural production and science. Analysis and design of structural members and frames. Heat and moisture problems in agricultural biology and their control. (4 s.h.)

4905 Soil and Water Engineering - Engineering principles and methods of soil and water conservation, drainage, and irrigation. (5 s.h.)

5403 Agricultural Environmental Engineering I - Effects of environmental variables--temperature, air-velocity, radiant energy flux, humidity, light, air pollutants--on the growth, reproduction, and conversion efficiency of domestic animals and poultry. Physiological responses. Physical environment for storage of grains, seeds, and food materials. Environmental design; principles and methods of controlling environment, design for specific environmental factors--heating, cooling, control of radiation. Specialized problems in animal housing, food and feed storage, plant growth chambers, etc. (3 s.h.)

5413 Agricultural Engineering II - Energy-flow approach to studying the plant-soil-water atmosphere complex. Soil environment including moisture and heat flow. Plant responses to and effects on micro-environment. Energy exchange between the plant and the surrounding environment. Environmental requirements of plants. Engineering for a desirable plant micro-climate. (3 s.h.)

Departmental courses for non-majors:

2614 Fundamentals of Agricultural Engineering - Introduction to the major fields of engineering principles applied to agriculture: power and machinery, soil conservation, rural electrification, farm structures, and agricultural processing. (4 s.h.)

2973 Drainage and Erosion Control - Application of engineering principles to the solution of soil- and water-management problems with emphasis on land grading, field drains, open-ditch and grass waterway designs. (3 s.h.)

3013 Agricultural, Municipal, and Industrial Waste Management - The types, nature, and volumes of agricultural, municipal, and industrial wastes and the effect of these wastes on the environment. The control, management, and reuse of wastes to include final disposal. (3 s.h.)

3403 Structures and Environment for Agriculture - Physical environmental factors influencing production of animals and greenhouse plants. Methods of control. Space, light, temperature, moisture, gases: their relationships in the design of production buildings. Elements of building design. (3 s.h.)

4973 Irrigation - Methods of applying supplemental water to soils to supply moisture essential for plant growth; sources of water; measurement of irrigation water; pumps, conveyance structure, economics, and irrigation for special crops. (3 s.h.)

*Courses with left-hand digit 1 or 2 are normally open to freshman and sophomores, 3 or 4 to juniors and seniors, 5 to graduate students or to top-caliber seniors with special permission, and 6 to graduate students only.

INSTITUTION: UNIVERSITY OF ARKANSAS (FAYETTEVILLE)

PROGRAM: Environmental Science, Environmental Engineering, Civil Engineering

DEPARTMENT: Colleges of Agriculture and Home Economics, Arts and Sciences, and Engineering

DEGREE: Bachelor of Science in Environmental Science [interdisciplinary] (B.S.); Master of Science in Environmental Engineering (M.S.En.E.); Master of Science in Civil Engineering with Environmental Option (M.S.)

CONTACT: Dr. Hugh M. Jeffus, Coordinator
Environmental Science Program
College of Engineering
University of Arkansas
340 Engineering Building
Fayetteville, Arkansas 72701
(501) 575-4955

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Arkansas at Fayetteville has declared its environmental training programs to be an "area of excellence" within the institution. At least three major degrees fall under this environmental studies rubric at Arkansas--the B.S. in Environmental Science implemented in 1972, the M.S. in Environmental Engineering also implemented in 1972, and the M.S. in Civil Engineering with an Environmental Option. All seek to give the student a practical, non-theoretical training in preparation for work in industry and the private sector.

The objectives of the interdisciplinary B.S. degree in Environmental Science are four-fold: 1) to expose students at the undergraduate level to many different facets of environmental studies (e.g., waste management, air and water pollution, economics of environmental management, pesticide management); 2) to help students better understand people and the institutions which bring about change in our society in order to facilitate work with problem solvers and to inform citizens about issues concerning them; 3) to prepare students for in-depth environmental studies at the graduate level; and 4) to enable them to work as problem solvers with problem solvers (e.g., engineers, sanitation experts, landscape designers, and others interested in protecting and improving the environment). In addition to basic courses in biological, social, and physical sciences, mathematics, and communications, students must take a number of environmental science courses designed especially for this major. Degrees are awarded either in the College of Agriculture and Home Economics or in the College of Arts and Sciences, whichever the student chooses.

The M.S. in Environmental Engineering was originally developed because students in chemical, electrical, mechanical, and agricultural engineering wanted an industrial background upon completion of their coursework. Rather than award them the M.S. in Civil Engineering, which would not accurately represent their training, the M.S.En.E. was instituted. The curriculum offers a wide spectrum of environmentally-related courses.

The M.S. in Civil Engineering with Environmental Option closely parallels the M.S.En.E. in terms of coursework. However, the former degree offers a more intensive engineering plan of study and requires credits beyond those for the Environmental Engineering degree.

The University of Arkansas (Fayetteville) operates the basic facilities necessary to train its students currently, but faculty note that funding is needed to maintain equipment and to provide needed additional space. The faculty in the Department of Civil Engineering who are involved in the environmental training programs are actively involved in research. Current projects include defining the needs of a community for water and wastewater treatment facilities; investigating the feasibility of transporting coal from Montana and Wyoming to Arkansas via a vast water pipeline and the energy and water-pollution considerations of such an endeavor; conducting studies of air pollution from paper mill waste treatment facilities, volatile chemical emissions from wastewater lagoons, and the impact of individual household disposal systems and septic tank tile fields; and reviewing the technology available to water systems in rural areas.

The research funding currently in effect totals $102,600. Sponsoring agencies include the Environmental Protection Agency, Arkansas Office of Public Safety, Office of Water Research and Technology, Arkansas Department of Soil and Water Resources, Southwestern Electric Power Company, National Science Foundation, and the university.

PROGRAM REQUIREMENTS

The B.S. in Environmental Science requires the completion of 132 semester hours including a core of Environmental Science courses (crosslisted in the Departments of Agricultural Engineering, Agronomy, Entomology, and Civil Engineering). The M.S. in Environmental Engineering requires a B.S. degree in engineering or a B.S. degree with courses in calculus, statics, dynamics, mechanics of materials, hydraulics, hydrology, civil engineering fundamentals, and thermodynamics or electric circuits and machines. (These courses should require approximately one calendar year to complete in addition to the graduate courses.) The M.S. in Civil Engineering with Environmental Option requires a B.S.C.E. Generally, Master of Science degree candidates must complete a minimum of 30 semester hours. A minimum of 12 semester hours must be taken in the major department exclusive of a thesis and a minimum of 18 hours must be taken in engineering.

CURRENT FACULTY, STUDENTS, GRADUATES

Five full-time faculty members divide their time evenly between teaching and research in the environmental program within the Department of Civil Engineering. All are paid by the university; but if research projects become unmanageable, non-tenured research associates are occasionally added to the staff for the duration of the project and paid by that grant money.

There are approximately 25 full-time undergraduate Environmental Science majors (1/3 are women), one M.S.C.E. with Environmental Option candidate (three more just graduated), and five full-time and 30 part-time (FTE=20) M.S.En.E. students. The first graduates are just now completing the B.S. in Environmental Science program, but their annual numbers should average about 15 graduates per year. The enrollment in the M.S.En.E. program is relatively stable (eight graduates per year) and is composed in great measure by students at the Graduate Institute of Technology, a unit of the Fayetteville campus in Little Rock.

The enrollment statistics reflect in part the job market in engineering and the lack of graduate student support available. There are graduate research slots open at the master's degree level, but the starting salaries and pay increments offered B.S. graduates entice potential graduate students away from the university (with its comparatively meager salaries) and into industry. Also, the faculty can supervise only a limited number of graduate students and still teach and conduct the research projects that employ those students. The ratio of jobs to students is approximately 5:1 at the B.S. level and 2.5:1 at the M.S. level. Placement is roughly one-third in industry, one-third in consulting, and one-third in government (regulatory agencies, pollution control departments, etc.); but recently faculty have noted a shift by graduates from industry and government to the private consulting firms. Students are recruited to the graduate environmental programs from the undergraduate student body and from other "hard sciences" where the job market is considerably less open.

PROGRAM PROJECTIONS

Given the current high level of involvement by the faculty in teaching and research, plans to move into the energy area in terms of curriculum have been postponed. No additional staff members are expected to be added in the next five years. Faculty predict a steady, though not dramatic, growth in environmental programs, but note that regulations from the Environmental Protection Agency can drastically affect the type of training necessary for tomorrow's graduates. There are no plans to develop a program at the doctoral level at this time; rather, Arkansas wants to maintain and upgrade its current "area of excellence" in the environmental sciences.

COURSE DESCRIPTION

Environmental Science core courses:

ENSC 1003 Environmental Science - Series of lectures and discussions introducing the topic of environmental sciences including factors related to water, soil, and air quality. Taught jointly by agricultural, arts and sciences, and engineering faculties. (3 s.h.)

ENSC 1203 Soils and Man's Environment - Soils as a natural resource in relation to man's environment. Chemical, physical, and biological properties of soils are studied from the viewpoint of being a resource that can be both a pollutant and polluted. (Same as Agronomy 1203) (3 s.h.)

ENSC 2003 Environmental Management - Man's interaction with the air, water, and land environment in which he lives. The role of engineering as well as other disciplines in the control of pollution for the health and welfare of mankind. (Same as Civil Engineering 2003) (3 s.h.)

ENSC 3013 Waste Management - Types, nature, and volumes of agricultural, municipal, and industrial wastes and the effect of these wastes on the environment. Control, management, and reuse of wastes to include final disposal. (Same as Agricultural Engineering 3013 or Civil Engineering 3013) (3 s.h.)

ENSC 4043 Pesticides Ecology - Development and classifications of pesticides, programs of use and environmental interactions. (Same as Entomology 4043) (3 s.h.)

ENSC 4413 Economics of Environmental Management - An economic approach to problems of evaluating private and social benefits and costs of altering the environment. Emphasis given to the interaction of individuals, institutions, and technology in problems of establishing and maintaining an acceptable level of environmental quality. (Same as Agricultural Economics 4413) (3 s.h.)

Recommended courses in Environmental Science:

BOT 4504 Principles of Plant Ecology - Plants in their environments, emphasizing field methods and vegetation communities of Northwest Arkansas. (4 s.h.)

ZOOL 4814 Limnology - Physical, chemical, and biological conditions of inland waters. (4 s.h.)

CE 5743 Aquatic Biology for Engineers - Fundamentals of aquatic biology and biological systems applied to environmental

CE 5743 (Cont'd) - engineering. Familiarizes the student with limnological concepts and methods, field sampling techniques, and laboratory methods commonly associated with stream pollution and water quality problems. (3 s.h.)

BACT 4613 Public Health and Sanitation - Public health aspects of disease spread, environmental pollution, and food contamination, with emphasis on sanitary practices applicable in control. (3 s.h.)

CE 4263 Public Health Engineering - Investigation of engineering practices in the public health field pertaining to epidemiology, biostatistics, and disease transmission, including the concepts of sanitation practices in supplying milk, food, and water. Sanitary engineering applications to disease areas, major pollution sources, and industrial hygiene are included. (3 s.h.)

CE 5753 Air Pollution - Terminology, theory, and laboratory aspects of air pollution. Emphasis placed on the interpretation of laboratory data for effective engineering control technology. (Same as Ch.E. 5753) (3 s.h.)

Environmental Engineering courses:

CE 3203 Environmental Engineering - Introduction to fundamentals. Course emphasis is upon water supply and wastewater treatment. (3 s.h.)

CE 4223 Surface Water Hydrology - Detailed investigations of hydrologic runoff relationships of surface and groundwater flow. Study of hydrograph and routing techniques as well as evaporation and sedimentation of storage reservoirs. Application of hydrologic techniques to engineering design. (3 s.h.)

CE 4243 Water and Wastewater Process Design - Application of physical, biological, and chemical operations and processes to the functional design of water supply and transmission as well as water and wastewater treatment plants. (3 s.h.)

CE 4253 Water Resource Planning and Economics - Investigation of water-resource projects from the broad engineering viewpoint of the impact on society of design, justification, financing, construction, and operation. Emphasis is placed on engineering economy studies of public works projects, and the political aspects of decisions by public works agencies. (3 s.h.)

CE 4263 Public Health Engineering - (see above)

CE 4273 Water Resources Planning and Design - Planning, design, and economics of water supply and wastewater disposal units. Topics include the analysis and design by modern optimization techniques to minimize construction and operational costs in meeting required water quality standards. (3 s.h.)

CE 4283 Solid Waste Management - Refuse collection and disposal with emphasis on system analysis in organizing and operating collection systems, methods of volume reduction and disposal and an economic evaluation of solid waste disposal problems. (3 s.h.)

CE 5234 Water and Wastewater Analysis - Basic concepts of each of the eight fields of chemistry are reviewed in light of their application to sanitary engineering. Quantitative determinations of constituents in water and wastewater are presented. Introduction to principles of bacteriological laboratory techniques. (4 s.h.)

CE 5253 Sanitary Microbiology - Fundamental and applied aspects of microbiology and biochemistry relating to water-quality control, wastewater treatment, and stream pollution. (3 s.h.)

CE 5273 Industrial Water Supply and Wastes Treatment - Industrial water requirements. Limitations of water quality and quantity. Stream pollution investigation. Study of industrial processes and how they affect water supply, sewage treatment, and stream recovery. Treatment and disposal of industrial wastes. (3 s.h.)

CE 5293 Water Treatment & Distribution System Design - Design of industrial and municipal water treatment plants. Discussion of raw and treated water requirements for the several areas. Distribution system analysis and design including distribution storage and pumping. (3 s.h.)

CE 5723 Radiological Health Engineering - Basic concepts of radiation. Radiation sources, physical and biological effects, protective measures. Engineering uses of radiation and radioactive isotopes. (3 s.h.)

CE 5734 Advanced Wastewater Process Design and Analysis - Application of advanced techniques for the analysis and design of wastewater treatment facilities. Physical, chemical, and biological processes for removing suspended solids, organic solids and nitrogen and phosphorous will be investigated. Laboratory treatability studies will be used to develop design relationships. (4 s.h.)

INSTITUTION: UNIVERSITY OF CINCINNATI

PROGRAM: Air Pollution, Industrial Hygiene

DEPARTMENT: Environmental Health

DEGREE: Master of Science in Air Pollution or Industrial Hygiene
Doctor of Philosophy in Air Pollution or Industrial Hygiene

CONTACT: Dr. Bernard E. Saltzman
Environmental Hygiene Program
Department of Environmental Health
Room 107, Kettering Lab
University of Cincinnati
Cincinnati, Ohio 45267

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

According to a recent publication by the Department of Environmental Health at the University of Cincinnati, its "scientific and educational interests . . . are largely a response to the need to understand the nature of environmental hazards, to probe their biologic and ecologic impact, particularly their effects on human health, and to develop methods of prevention and control." As part of that response, graduate study sequences in Industrial Hygiene and Air Pollution were developed in 1954 and 1960 respectively. The Industrial Hygiene program is the second or third oldest in the U.S., and the university holds the nation's oldest grant for Air Pollution training. The Air Pollution program is conducted jointly with the Department of Civil and Environmental Engineering in the College of Engineering. The bulk of students following the Industrial Hygiene program are employed in the private sector, while those students trained in Air Pollution usually find jobs in control agencies.

The Department of Environmental Health and the Industrial Hygiene program within it are heavily engaged in research and outreach programs. The faculty offer one-to-two week courses for professionals in industrial hygiene and one- to three-day courses on occupational health hazards for employers and employees of small businesses in an area within 150 miles of Cincinnati. The Department also offers a weekly seminar open to the university community and the public to which "distinguished leaders in their specific fields are invited to present new scientific information and new approaches to critical problems."

Facilities include laboratories in air flow measurement and calibration, dust sampling and evaluation, instrument calibration, air sampling, noise measurement and control, industrial hygiene chemistry, and respiratory protection. The nearly research units of the National Institute for Occupational Safety and Health (NIOSH) and the Environmental Protection Agency (EPA) provide excellent facilities to students and staff; both federal units maintain a close relationship with the Department. NIOSH has recently designated the University of Cincinnati as one of nine Educational Resource Centers in the country in industrial hygiene and safety, industrial health nursing, and occupational medicine; the center is charged with developing an outreach program and providing materials to regional schools in these industrial areas.

In addition to the $500,000 annual NIOSH grant (five years), the program has received funding from EPA, the Energy Research and Development Administration (now the Department of Energy), and the Occupational Safety and Health Administration. Grant monies are critical to the program because they are the major source of faculty salaries and graduate student stipends.

PROGRAM REQUIREMENTS

Students entering the programs in Industrial Hygiene and Air Pollution must have a baccalaureate degree and have majored in chemistry, biology, engineering, or related fields. Formal requirements for the M.S. degree are the satisfactory completion of at least 45 quarter credit hours of graduate courses, including research, and the preparation of a thesis. The Ph.D. degree requires completion of 135 graduate credits, 45 of which must be earned in residence at the University of Cincinnati, and an acceptable dissertation. All students complete a core program of lecture courses, seminars, and research in the Environmental Health Department and also a group of electives preparing each of them for a chosen area of specialization in professional practice or teaching. The time required for completing the M.S. degree varies from one to two years. For a majority of students with a B.S. degree, four years of graduate work are necessary to complete the requirements for the Ph.D. degree

CURRENT FACULTY, STUDENTS, GRADUATES

Ten full-time faculty members, who devote an appropriate fraction of their time to teaching and the remainder to research, serve students in these programs. As of Autumn 1977, enrollment figures were as follows:

AIR POLLUTION

M.S.		Ph.D.	
Full-time	4	Full-time	2
Part-time	4	Part-time	6

INDUSTRIAL HYGIENE

M.S.		Ph.D.	
Full-time	23	Full-time	8
Part-time	22	Part-time	0

The differences in enrollment between these two areas is in part due to the financial support available to graduate students. Graduate student support currently comes from a variety of sources: EPA loan fund, NIOSH stipends, ERDA stipends in Industrial Hygiene, research work on department grants and contracts, summer employment with EPA and NIOSH, armed forces service, and foreign governments. The shrinking support from EPA for Air Pollution training has reduced the number of students sustained in this area of concentration, while growing support from NIOSH and OSHA continues to draw increasing numbers of students into the Industrial Hygiene program.

For both programs combined, there are approximately 16 M.S. and 2-3 Ph.D. degrees awarded annually. Upon completion of the M.S. degree, approximately 10 percent continue work on a Ph.D. and many do so at the University of Cincinnati. Of the 105 graduates over the last 8 years, 60 percent have taken jobs in the private sector and 40 percent have entered government work. There are numerous job opportunities due to the legislation requiring industry to provide safe working conditions.

PROGRAM PROJECTIONS

The declining financial support in Air Pollution makes the future of that program tenuous; the faculty can be sustained through other funding sources, but the graduate students cannot. There has been some discussion related to expansion of the program into the water pollution area. The NIOSH Educational Resource Center grant will help to build the Department's Industrial Hygiene program and develop a graduate program in Industrial Safety.

COURSE DESCRIPTION

Environmental Health: 701, 702, 703 Environmental Health Seminar - Lectures and discussions covering a broad range of problems in environmental health led by guest lecturers in their field. (1 q.h. each qtr.)

707, 708, 709 Environmental Hygiene Technology I - Lectures, demonstrations on problems arising from man's environment. Industrial hygiene, air pollution fundamentals and practices. (3 q.h. each qtr.)

725, 726, 727 Teaching Practicum in Environmental Health - Practice of assisting and teaching in environmental courses by special arrangement with faculty member who will provide supervision. (2 q.h. each qtr.)

741, 742 Air Sampling and Analysis I and II - Calibration of sampling equipment, collection, analysis of pollutant gases, vapors, particulate matter. (3 q.h. Aut., Win. qtr.)

747, 748 Environmental Sanitation - Basic principles, practices of water and public health engineering. Municipal refuse collection, disposal; food, milk sanitation; pest control; housing, recreational sanitation. (2 q.h. each qtr.)

751, 752 Occupational Dermatology - Applied physiology and anatomy of skin. Etiology, evaluation, treatment, and prevention of environmental dermatoses. (2 q.h. Aut., Win. qtr.)

771 Biological Effects of Air Pollutants - Investigation and identification of the health effects of air pollutants on human beings, other animals, and plants. (2 q.h. Spr. qtr.)

772 Energy and Environment - Environmental impact studies of energy generation and utilization including fossil-fuel, nuclear power, waste recycling. (3 q.h. Win. qtr.)

775 Industrial Hygiene Laboratory - Evaluation of chemical, physical hazards in industrial workplaces. Potential hazards include noise, glare, heat, dust, solvents, electromagnetic radiation. (3 q.h. Spr. qtr.)

779 Industrial Ventilation - Principles of air flow through ventilation systems and their design for industrial uses starting with simple foods and progressing through complex systems. (2 q.h. Win. qtr.)

780 Air Pollution Meteorology - Theory, application of meteorology applied to air pollution, including diffusion computations, tracer studies, urban diffusion experiments, air quality cycles, pollution incidents. (4 q.h. Win. qtr.)

781 Introduction to Occupational Health - Principles, philosophies, basic concepts of medical engineering, and other disciplines in research and practice of occupational health. (1 q.h. Aut. qtr.)

782 Toxicology - Introduction - Entry, action and elimination of toxic chemicals; dose-response relationships; experimental toxicology, design, interpretation and application of the data. (3 q.h. Win. qtr.)

785 Introductory Physiology - Basic biological principles with lectures, demonstrations on structure function in mammals. (3 q.h. Aut. qtr.)

790 Physical Aspects of the Environment - Principles and techniques of recognizing and evaluating problems of non-ionizing radiation, ultarviolet, visible, infrared, and microwave. (1 q.h. Spr. qtr.)

791 Master's Thesis Research - Credits to be arranged.

792 Principles of Ergonomics - Concepts, criteria to achieve optimal mutual fitting of capabilities of the worker. Biomechanics, (heat, cold, vibration, noise, chemicals) fatigue, vigilance, behavioral factors. (2 q.h. Spr. qtr.)

796 Introduction to Statistics - Descriptive statistics, probability, estimation, statistical errors, parametic and nonparametric hypothesis testing, statistical fallacies. Emphasizes applied-practical aspects. (4 q.h. Spr. qtr.)

834, 835, 836 Environmental Quality Management- Seminar encompassing social, technical, economic, and institutional issues of water, solid wastes, noise, and community development programs. (2 q.h. each qtr.)

873 Basic Industrial Safety - Content, administration and implementation of safety programs in industry. Covers good practices and governmental regulations. (2 q.h. Aut. qtr.)

875 Basic Health Physics - Evaluation of exposures to ionizing radiation. Air sampling, personal protection and monitoring of industrial exposures. (2 q.h. Win. qtr.)

877 Theory and Applications of Aerosol Technology - Applications of industrial aerosol technology: sampling, characterization, statistical methodology. (2 q.h. Spr. qtr.)

901, 902, 903 Instrumental Methods of Analysis of Pollutants I, II, III - Lecture lab. Autumn: Chromatography; Winter: Air monitoring instrumentation; Spring: Spectroscopy. (3 q.h. each qtr.)

904, 905, 906 Environmental Hygiene Technology II - Field trips to representative industrial plants to illustrate principles of industrial operations and methods employed in controlling physical, chemical hazards. (3 q.h. each qtr.)

973 Design of Environmental Quality Monitoring Programs - Objectives, types of standards and monitoring programs, statistical aspects of monitoring and of anlytical quality control. (2 q.h. Spr. qtr.)

991 Doctoral Disseration Research - Credits to be arranged.

771-5; 871-5;971-5 Special Topics-Air Pollution - Seminars, or tutorial sessions dealing with special topics in air pollution related to research and application basic to field of environmental health. (cr. arr.)

781-5; 881-5; 981-5 Special Topics - Industrial Hygiene - Seminars or tutorial sessions dealing with special topics in industrial hygiene as related to research and application basic to field of environmental health. (cr. arr.)

INSTITUTION: UNIVERSITY OF CINCINNATI

PROGRAM: Civil and Environmental Engineering (Environmental Engineering and Sciences)

DEPARTMENT: Civil and Environmental Engineering

DEGREE: Master of Science
Doctor of Philosophy

CONTACT: Dr. Louis M. Laushey, Head
Department of Civil and Environmental Engineering
College of Engineering
University of Cincinnati
Cincinnati, Ohio 45221
(513) 475-3648

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Engineering and Sciences program at the University of Cincinnati permits master's and doctoral degree candidates to specialize in a number of areas including air and water pollution control, solid wastes control, and water and waste chemistry and microbiology. Current program objectives are "to provide a broadly based interdisciplinary program of coursework, research, and practical training which enables graduates to function in a wide range of environmental quality management and engineering operations." To achieve this blend of research and practical application, many students alternate terms of coursework with cooperative work programs in related industries and government agencies."

The program enjoys the benefits of several nearby research units--those of the U.S. Environmental Protection Agency and the National Institute of Occupational Safety and Health. Other facilities available in the community include the Herman Schneider Laboratory of Basic and Applied Science Research, the Laboratory of Basic and Applied Nuclear Research, the Kettering Laboratory and Institute of Environmental Health, Children's Hospital Research Foundation, the Robert A. Taft Sanitary Engineering Center, the Ohio River Valley Sanitation Commission, and the Ohio River Division of the Corps of Engineers. The departmental laboratories are equipped "to perform research in the quality of air and water and research in solid waste characterization and management."

Research funding from the Environmental Protection Agency (loan program in air, training grant in water) and other agencies and consulting work by individual faculty members provide financial remuneration and practical experience to students. Current EPA-financed projects include a training film on methodology for technicians and studies on "Graduate Training in Water Pollution Control" and "Effect of Particulates on Disinfection of Enteroviruses in Water by Chlorine Dioxide."

Weekly seminars on environmental topics co-sponsored by the Department and the EPA and open to the public provide an ideal setting for "significant interaction" among students, faculty, professionals, and community members. Presentations in the Autumn 1977 series included "Control Priorities for Toxic Pollutants in Water," "Charging the Polluter," and "Beyond Detection? Carcinogens and Toxicants in Our Water."

PROGRAM REQUIREMENTS

For admission to the Environmental Engineering program, applicants should have a bachelor's degree in engineering or science, a record of high scholarship, and the ability for advanced study and research. Graduates of related noncivil engineering curricula may be required to take preparatory courses.

The minimum requirements for a M.S. degree are 36 graduate quarter credits of coursework and 9 credits of thesis research or 45 total credits. If a non-thesis option is granted by the student's committee, a minimum of 51 graduate quarter hours is required, 45 of which should be formal courses (not thesis, research, readings). With either option, a minimum of 12 graduate credits of mathematics plus science are required.

For the Ph.D. degree, 135 graduate credits past an acceptable B.S. degree, or 90 credits past an acceptable M.S. degree are required. Of these, 45 credits must be under the direction of the Civil and Environmental Engineering faculty. Hours of coursework vary from 45 to 60 depending on how many hours are allotted to the dissertation (30-45 range).

CURRENT FACULTY, STUDENTS, GRADUATES

Seven full-time faculty in Environmental Engineering and Sciences and two staff members from related areas as well as six adjunct faculty (from EPA, etc.) serve approximately twenty-two full-time and fifty-five part-time graduate students in this program. Most students receive some financial support (air loans, water training grants, assistantships, part-time jobs).

The average number of graduates annually (20-25) is growing steadily. Statistics for recent years reveal 48 percent of the graduates have entered government work; 16 percent, consulting; 16 percent, industry; and 20 percent, teaching, other employment, or unknown. Extensive follow-up records are maintained in the Department. Only a few master's students (10 percent) pursue doctoral degrees--an indication that the M.S. degree program currently prepares one well for future careers.

PROGRAM PROJECTIONS

Though the program currently operates several well-equipped laboratories, its recent self-evaluation report notes, "Reductions in outside funding through the training grant mechanism coupled with significant reductions in University contributions has resulted in a leveling off in laboratory operations over the past five years. It does not appear that this trend can be reversed unless governmental funding of environmental programs is increased substantially." That same report indicates that "the instructional program is expected to remain essentially in its present form" and "more emphasis . . . placed on Systems Analysis and Mathematical Modelling." Faculty assessments are that the current program strengths lie in water and air training, but that financial and laboratory support are needed to promote a reputable solid waste curriculum.

COURSE DESCRIPTION*

Civil and Environmental Engineering:

614 Solid Waste Disposal - Introduction to the problem of solid wastes and the methods used for their disposal. (2 q.h.)

618, 619 Environmental Microbiology I - Basic principles of biology, and biochemistry with emphasis on the activities of microorganisms and their effect on man and his environment. (2 q.h. each qtr.)

620 Environmental Microbiology II - Microbiology of air, solid wastes, soil wastes, soil, water and wastewater. (2 q.h.)

625 Water Pollution Control - Application of engineering and scientific principles in waste treatment. (3 q.h.)

635 Air Engineering and Control of Gaseous Air Pollutants - Fundamental gas laws, air engineering (hoods, ducts & blowers), control of gaseous pollutants (absorption, adsorption and incineration). (3 q.h.)

636 Air Engineering - Fundamental gas laws, psychometrics; heating and coding; design of hoods and ducts; fan laws and fan selection. (2 q.h.)

637 Control of Gases Pollutants - Includes process control as well as effluent control by absorption, adsorption and incineration. (2 q.h.)

640 Fundamentals of Small Particle Behavior - Physics of particles: size and size distribution, mechanics of motion, agglomeration, diffusion, electrical effects and light scattering. Applications to sampling deposition, visibility. (3 q.h.)

641, 642, 643 Environmental Engineering Seminar - Lecture and discussions of topics relating to the control of the environment. Guest lecturers as well as student presentations. (1 q.h. each qtr.)

644 Fundamentals of Small Particle Behavior - Physics of particles; size and size distribution, mechanics of motion, agglomeration, diffusion, electrical effects and light scattering. (2 q.h.)

645 Environmental Sanitation - A survey of public health practices as related to environmental control. Insect and rodent control, food and milk sanitation, refuse disposal, housing. (2 q.h.)

646 Environmental Microbiology I - Basic principles of biology, microbiology, and biochemistry with emphasis on the activities of microorganisms and their effect on man and his environment. (4 q.h.)

647 Environmental Chemistry I - Analytical methods in environmental chemistry. Purposes, procedures and principles of the analysis of water and liquid wastes. (4 q.h.)

649 Environmental Microbiology II - Microbiology of air, solid wastes, soil, water and wastewater. (3 q.h.)

650 Environmental Microbiology III - Examination of microbiological techniques and applications useful in applied microbiology. To be taken concurrently with Environmental Microbiology II. (1 q.h.)

651 Water Pollution Control - Application of scientific and engineering principles to receiving water quality control. (3 q.h.)

652 Environmental Chemistry II - Current water chemistry theories and their application to the treatment of water, wastewater, and industrial waters. (3 q.h.)

653 Design of Environmental Control Systems - Unit process, unit operation concept applied to design of systems used for environmental control. (5 q.h.)

661 Air Pollution Control - A general course. Air quality management, effects and control engineering, administrative and legal aspects of control programs. (3 q.h.)

662 The Air Pollution System - An overview of air pollution control: major pollutants, their characteristics, effects and standards; natural and man-made sources, sinks; meterological transport; air pollution literature and its use. (3 q.h.)

663 Automotive Air Pollution anc Control - Causes of air pollution in internal combustion engines. Methods of reducing pollution, test methods, legal and political aspects of control. (3 q.h.)

664 Air Pollution Law, Regulations and Management - Technical aspects of air pollution control programs and organization and management

664 (Con't) - of control programs in government and industry. Air pollution laws and regulations in the U.S. and abroad. (4 q.h.)

665 Air Pollution and Combustion Chemistry - Chemical and physical fundamentals of combustion processes and formation of primary gaseous pollutants. Introduction to photochemical smog and formation of secondary pollutants. (3 q.h.)

667 Effects of Air Pollutants - Review and analysis of the data on the effects of air pollutants on humans, animals, plants and materials and their relationship to ambient standards. (2 q.h.)

709 CE Lab - Instrumental methods of water and air analysis, using gas chromatography, atomic, adsorption, UV-visible and infrared spectrophotometry. (3 q.h.)

718 Solid Waste Analysis - Analytical methods in environmental chemistry. Purposes, procedures, and principles of the analysis of solid wastes. (3 q.h.)

754, 755, 756 Design of Environmental Control Systems - Unit process, unit operation concept applied to design of systems used for environmental control. (2 q.h.)

741 Air Pollution Engineering Laboratory - Particle measurements, source and collector performance testing. (3 q.h.)

742 Photochemical Air Pollution - Photochemical air pollution, atmospheric reactions; air pollution effects in atmosphere. (3 q.h.)

690 Watershed Hydraulics - Energy, momentum, flow rates and profiles. Groundwater, wells. Sedimentation, erosion, transport. River regulation, equilibrium and regime; long-term effects of man's works. (3 q.h.)

691 Environmental Hydraulics - Interdisciplinary hydraulics of fluid and solid transport in environmental engineering. Piping systems and networks. Optimization. Water hammer. Corrosion control. (3 q.h.)

692 Hydraulic Design of Plants - Hydraulic design for wastewater treatment and pumping facilities. Hydraulic models, pilot plants. Control structures. Pumps, power conversion. (3 q.h.)

693 Hydraulic Engineering I - Open channel flow: nonuniform and unsteady. Reservoir and river flood routing. Flow through culverts. Sanitary engineering hydraulics. (3 q.h.)

694 Hydraulic Engineering II - Waves. Erosion. Pipe networks. Water hammer. Ground water flow, wells, and flow nets. Sedimentation.

694 (Cont'd) - Model studies. (3 q.h.)

695 Groundwater Hydrology - Groundwater hydraulics. Water well design. Basin development. Underground disposal, pollution. (2 q.h.)

697 Environmental Hydrology - Interdisciplinary hydrology. Hydrology balances. Statistical methods. Rainfall-runoff process. Urban watershed models. Control methods. (3 q.h.)

698 Water Resources Control - Basic concepts of open channel flow. Channel transitions and controls. Control structures. Storage routing. (2 q.h.)

699 Hydrology - Interdisciplinary study of ponds, lakes, and rivers. Hydrographic methods of analysis. Limnology. Eutrophication. Renovative processes. (2 q.h.)

* Courses listed are taught by Departmental faculty, but courses acquired from other departments are utilized extensively, especially from the Department of Environmental Health, Department of Chemical and Nuclear Engineering, and Department of Mathematics.

INSTITUTION: UNIVERSITY OF CINCINNATI

PROGRAM: Environmental Health

DEPARTMENT: Environmental Health

DEGREE: Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Gary Cooper
Environmental Health Division
Department of Environmental Health
Room 36, Kettering Lab
University of Cincinnati
Cincinnati, Ohio 45267
(513) 872-5725

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Institute of Environmental Health at the University of Cincinnati offers coursework leading to M.S. and Ph.D. degrees with specialization in environmental health (environmental biology, biochemistry, physiology and pathophysiology). Training and research efforts are designed "to enhance our understanding of man's ecosystem so that detrimental effects can be prevented and controlled." Master's degree candidates formulate plans of study that introduce them "to the sources, methods of evaluation, and entry and effects of important hazardous materials to the general population." Doctoral candidates bring a specialization in a basic scientific area (e.g., biochemistry, microbiology, chemistry, zoology, physiology, pharmacology, engineering) to bear on fundamental research questions and problem-solving strategies in environmental health. The division is oriented to the doctoral level and the training of specialized environmental scientists.

Research funds essentially constitute faculty salaries in this program and come from a variety of sources: National Institute of Health, National Institute of Occupational Safety and Health, U.S. Army, American Petroleum Institute, and the Environmental Protection Agency. Projects include studies of behavioral aspects of auto-exhaust sulfates, ecological characteristics of estuaries, water reuse systems, and coal pollutants. Examples of current areas of research exploration are:

(1) The role of trace metals in human health and disease as affected by environmental factors;
(2) Pulmonary problems of environmental origin; and
(3) Development of environmental quality study techniques and analytical methods.

Facilities available to students and staff are extensive and located both on campus and in the environs of Cincinnati. Among these are laboratories in environmental hygiene technology, environmental medicine, epidemiology, biostatistics, toxicology, physiology, neurophysiology and behavior, and basic biological sciences. Facilities for animal and human subject investigations are also available. The U.S. Environmental Protection Agency and the National Institute of Occupational Safety and Health operate research units nearby and maintain cooperative programs with the Department of Environmental Health.

PROGRAM REQUIREMENTS

Students must have or develop a basic science background for entrance into the Environmental Health program. All candidates complete a core program of lecture courses, seminars, and research and a set of professional electives preparing them for specialized career work. The time required for completing the master's degree ranges from one to two years; entry with a B.S. degree usually results in a four-year doctoral program.

Doctoral candidates are expected to understand biological mechanisms of response and are urged to take a course in biochemistry. If one's basic science background is a physical science, he/she should have a course in physiology. In addition to required basic science and envirommental health courses, all students must elect at least nine hours of additional coursework in environmental health although most elect more. Candidates will also be required to take a new course called Introduction to Environmental Health beginning in the fall of 1978. Elective hours enable the student to integrate his/her basic science background with environmental health problems. Students holding an M.S. degree begin research in their first year, while B.S. degreed students begin research upon completion of basic science courses.

CURRENT FACULTY, STUDENTS, GRADUATES

Eleven full-time faculty members with three-quarters time devoted to research and one-quarter time given to teaching and administrative duties serve the Environmental Health Division students (3 M.S., 13 Ph.D.). The number of graduates at the master's level has been declining, while the number at the doctoral level is increasing. Stipends, tuition fellowships, and research assistantships are available. Approximately one quarter of the program's graduates have entered industrial jobs with the remaining students entering government work (especially M.S. students) or university teaching and research (especially Ph.D.).

PROGRAM PROJECTIONS

Recent faculty additions have strengthened the curriculum in psychology and biochemical carcinogenesis. The program hopes to hire a staff member with specialization in respiratory physiology and needs someone with training in pulmonary physiology to develop the air pollution emphasis of the curriculum. Requirements and faculty appointments reflect an increasing degree of structure in the environmental health field.

With current legal regulations for toxicological and enviromental testing and monitoring, increased numbers of environmental health scientists will be needed in the next decade, according to division faculty. If government funding remains constant and economic factors do not interfere, the Environmental Health program at the University of Cincinnati should enjoy a stable, healthy future.

COURSE DESCRIPTION*

Environmental Health:

701, 702, 703 Environmental Health Seminar - Lectures and discussions covering a broad range of problems in environmental health led by guest lecturers considered leaders in their field. (1 q.h. each qtr.)

782 Toxicology I - Entry, action and elimination of toxic chemicals; dose-response relationships; experimental toxicology, design, interpretation and application of the data. (3 q.h.)

785 Introductory Physiology - Basic biological principles with lectures, demonstrations on structure, function in mammals. (3 q.h.)

787 Introduction to Biostatistics - Descriptive statistics, probability distributions, estimation sampling, types of error, significance level, test of hypotheses, sample size, correlation, linear regression. Emphasizes practical-applied aspects. (4 q.h.)

880 Toxicology II - Principles of absorption, distribution and excretion of foreign compounds. (4 q.h.)

*Courses represent fundamental requirements for students and are by no means all-inclusive. Students also take a biochemistry course and a mammalian physiology course as part of their preparation for research work.

INSTITUTION: UNIVERSITY OF CINCINNATI

PROGRAM: Occupational Medicine

DEPARTMENT: Environmental Health

DEGREE: Master of Science in Environmental Health (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Edward A. Emmett, M.D.
Department of Environmental Health
Division of Clinical Studies
University of Cincinnati Medical Center
231 Bethesda Avenue
Cincinnati, Ohio 45267
(513) 872-5284

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

According to a program brochure from the University of Cincinnati's graduate program in Occupational and Environmental Medicine:

> Occupational and environmental medicine is a clinical and research field of medicine of considerable social and professional importance. It is a medical speciality concerned with the diagnosis, prevention and treatment of diseases and injuries resulting from exposure to chemical agents, products or processes at work or within the environment. It is an attractive speciality for the physician interested in solving problems for which the hazardous environmental components can be probed and identified. It is a branch of medicine in which preventative measures will result clearly in the control or elimination of the health problems.

The Occupational Medicine program within the Department of Environmental Health offers graduate study leading to the M.S. and Ph.D. degrees. The program's two-year residency satisfies "the training requirements of physicians for certification in Occupational Medicine by the American Board of Preventative Medicine." Both residency and degree requirements are flexible enough to meet changing student interests and career objectives such as "(1) the delivery of medical care in an industrial setting or health maintenance organization, (2) research and teaching in an academic unit or national agency, or (3) health affairs administration at a corporate or governmental level."

The program benefits from a close proximity to numerous centers and facilities. Among these are a large Medical Center complex (Colleges of Medicine, Nursing and Health, and Pharmacy); three hospitals; the

College of Engineering; research units of the National Institute of Occupational Safety and Health and the U.S. Environmental Protection Agency; and a "large industrial complex with resources such as industrial medical and safety programs as well as potential hazards, which are materials for training."

A recent grant proposal enumerates the equipment and instrumentation housed in the Departmental laboratories: atomic absorption spectrometers; infrared, visible, and ultraviolet spectrophotometers; gas chromatographs; amino acid analyzer; X-ray diffraction equipment; electron microscopes; ultra centrifuges; scintillation counters; electrophoresis apparatus; air pollution monitoring instruments; noise evaluation equipment; a variety of sampling devices; dust counting equipment and ancillary apparatus; inhalation exposure chambers; cold rooms; experimental and clinical pulmonary function laboratories; a controlled temperature and humidity chamber; cell culture facility; audiometric room; trace metal facility for housing and feeding small animals under rigid environmental and nutritional control; and a clinical pathology section. Library and computer facilities are up-to-date and extensive.

Current grant monies from NIOSH, the National Institute of Environmental Health Sciences, and other government agencies (not EPA) and industrial contracts support the Occupational Medicine program and its faculty. Short-courses for physicians and EPA and NIOSH personnel and a mini-residency providing a one-month, intensive training session for physicians supplement the regular curriculum offerings.

PROGRAM REQUIREMENTS

Requirements for acceptance into the residency include graduation from an approved medical school and completion of at least one year of internship (or residency) in a relevant field from a program which is approved by the Council on Medical Educational Hospitals on the American Medical Association. Foreign students have additional requirements.

The curriculum is "formal" though "flexible" and "strives to blend practical clinical occupational medicine and patient care." The core curriculum in environmental and industrial hygiene, toxicology, epidemiology, and biostatistics "encompasses environmental hazards and principles of their control, clinical practice of occupational medicine and the planning, administration and evaluation of health problems." Electives provide concentration in areas such as "air pollution research and control, radiobiology and radiation health, applied psychiatry, environmental sanitation, experimental design, public health administration and other relevant subjects." Clinical activities, industrial hazard evaluations, and work with federal and local regulatory and research units enhance the training opportunities. A required residency in industry usually occupies one's third year in the program unless it has been completed prior to entry into graduate work.

CURRENT FACULTY, STUDENTS, GRADUATES

Four full-time and twenty part-time faculty serve eleven full-time and one part-time graduate students in the Occupational Medicine program. With little fluctuation, five degrees (mostly M.S.) are conferred annually on the average. There have been approximately 120 graduates from the program since its inception in 1952.

Stipends from NIOSH, the U.S. Navy, and foreign governments support currently enrolled students. Jobs are plentiful for those students completing the program. Graduates are employed in government (37%), industry, often as corporate medical directors in charge of environmental concerns (38%), consulting (under 5%), and academia (20%).

PROGRAM PROJECTIONS

No major curriculum shifts are anticipated in the Occupational Medicine program which currently is seen as flexible enough to allow diverse specialization in the field. There are no program limitations due to equipment and facilities though outside funding must continue. However, the enrollment does demand additional staff--a need which can be met if qualified people are found to fill the two currently open faculty lines and one line opening next fall. Graduates from this program should find an open job market for some time.

COURSE DESCRIPTION

Environmental Health:

701, 702, 703 Environmental Health Seminar - Lectures and discussions covering a broad range of problems in environmental health led by guest lecturers considered leaders in their field. (1 q.h. each qtr.)

704, 705, 706 Applied Psychiatry for Occupational Physicians - Seminar discussions, conferences, and interviews to provide understanding of the application of psychiatric methods to common occupational medical problems. (1 q.h. each qtr.)

707, 708, 709 Environmental Hygiene Technology I - Lectures, demonstrations on problems arising from man's environment. Industrial hygiene, air pollution fundamentals and practices. (3 q.h. each qtr.)

719, 720, 721 Topics in Clinical Toxicology II - Exposure, clinical effects, pathology, prevention and treatment of industrial toxicants for physicians. (1 q.h. each qtr.)

722, 723, 724 Occupational Medicine - Clinical practice of occupational medicine for physicians. (2 q.h. each qtr.)

731, 732, 733 Basic Science in Relation to the Skin - Three-quarter course which discusses anatomy, physiology, biochemistry of skin related to skin diseases, cutaneous toxicology. (1 q.h. each qtr.)

751, 752 Occupational Dermatology - Applied physiology and anatomy of skin. Etiology, evaluation, treatment, and prevention of environmental dermatoses. (2 q.h. each qtr.)

776 Introduction to Epidemiology - Methodology used in studies of disease in human populations. Examples of chronic disease and infectious disease epidemiology. Sources, collection, handling, interpretation of health data. (3 q.h.)

781 Introduction to Occupational Health - Principles, philosophies, basic concepts of medical engineering, and other disciplines in research and practice of occupational health. (1 q.h.)

787 Introduction to Biostatistics - Descriptive statistics, probability distributions, estimation sampling, types of error, significance level, test of hypotheses, sample size, correlation, linear regression. Emphasizes practical-applied aspects. (4 q.h.)

810, 811, 812 Environmental Health Medical Clinics - Diagnostic evaluation, clinical management of environmental health problems at appropriate clinics; includes services in general medicine, chest diseases, dermatology. (3 q.h. each qtr.)

816, 817, 818 Clinical Toxicology and Pharmacology - Bedside rounds and seminars illustrating practice of clinical toxicology as applied to drug overdoses and poisonings by nontherapeutic agents. (2 q.h. each qtr.)

831, 832, 833 Chemical and Biological Effects of the Human Environment - Pharmacological agents, agricultural chemicals, and trace metals. (2 q.h. each qtr.)

873 Basic Industrial Safety - Content, administration, and implementation of safety programs in industry. Covers good practices and governmental regulations. (2 q.h.)

880 Toxicology II - Principles of absorption, distribution and excretion of foreign compounds. (4 q.h.)

904, 905, 906 Environmental Hygiene Technology II - Field trips to representative industrial plants to illustrate principles of industrial operations and methods employed in controlling physical, chemical hazards. (3 q.h. each qtr.)

910 Industrial Toxicology Practice - Medical, toxicological evaluation of industrial materials, consumer products. (2 q.h. each qtr.)

INSTITUTION: THE UNIVERSITY OF DELAWARE

PROGRAM: Environmental Engineering

DEPARTMENT: Multidisciplinary (sponsored by College of Engineering)

DEGREE: Master of Applied Science
Master of Engineering in one of the departmental areas
Doctor of Philosophy in Applied Science
Doctor of Philosophy in Chemical Engineering
(or Applied Science)

CONTACT:
Dr. Lloyd A. Spielman
Committee Chairman of Environmental Engineering Program
Rm. 356, Dupont Engineering Building
University of Delaware
Newark, Delaware 19711
(302) 738-2431

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The College of Engineering in 1970 established an interdepartmental program in environmental engineering involving the departments of engineering, chemistry, and biology. This multidisciplinary program is available at the master's and Ph.D. level to all graduate students in engineering and students whose undergraduate majors were in chemistry, physics, or the biological sciences. Major subject areas include air and water pollution control, agricultural effects of pollutants, and environmental resources. The purpose of the program is to enable students with varied engineering and scientific backgrounds to increase markedly their ability to apply the tools and training of engineering to solve environmental problems. Students are first admitted to one of the engineering departments.

The degree requirements for this program are determined by the engineering departments to which the student is admitted. The environmental engineering program is coordinated by an Environmental Engineering Committee comprised of members from each of the departments of the College. Members of the Committee are available to assist students in developing a program of study oriented toward the student's area of special interest in environmental engineering.

The Civil Engineering Department has facilities for research in the environmental engineering disciplines with a supporting machine shop for constructing specialized research equipment. The environmental engineering laboratories contain equipment for conducting physical and chemical tests, as well as standard apparatus for chemical and biological analyses of water, wastewater, and air. The department also has access to late model analog and digital computing facilities for both instruction and research. Research in the chemical engineering laboratories includes air and water pollution control (particularly as related to abatement by catalytic means).

PROGRAM REQUIREMENTS

Applicants wishing to enter the program must first fulfill the requirements of the engineering department with which they want to be affiliated. Program officials state that undergraduates must have taken courses in environmental biology, general geology, chemistry and introductory environmental engineering if they enter the graduate program as University of Delaware undergraduates.

Candidates for the master's degree may pursue either the Master of Applied Science degree or a master's degree in one of the departmental areas. At the Ph.D. level, students in civil engineering and mechanical engineering work toward a Ph.D. in Applied Science and those in chemical engineering pursue the Ph.D. in Chemical Engineering or Applied Science.

The degrees of Master of Chemical Engineering (M.Ch.E.), Master of Civil Engineering (M.C.E.), Master of Electrical Engineering (M.E.E.), and Master of Mechanical and Aeorspace Engineering (M.M.A.E.) are conferred under the direction of those departments. General requirements for the master's degree in the College of Engineering include completion of 24 semester hours of approved course credit or equivalent, plus 6 hours thesis with an average grade of B (residence and foreign language not required). Six hours of thesis or 6 hours of research, or a combination of both are allowed. The minimum amount of credits without thesis is 30 semester hours. Students usually in the non-thesis program are required to pass a comprehensive examination. A maximum of 9 credit hours transferred from continuing education or from another institution may be applied to the degree hours required. For the Master of Civil Engineering, the student may elect, after consultation with a faculty advisor, to replace the thesis with nine credit hours of additional course work and a comprehensive examination.

For the Master of Applied Sciences degree, the requirements of the College of Graduate Studies must be satisfied. These require 30 credits, of which 6 shall be a thesis. In addition, 12 hours of course credit obtained in 800-level courses are normal requirements for the degree.

General requirements for the Doctor of Philosophy degree include at least three academic years of work subsequent to the baccalaureate degree. At least one continuous academic year must be devoted exclusively to full-time study in the major field at the University. Students are also expected to pass comprehensive and final examinations and prepare a thesis. Theses may be written in absentia in chemical, civil, and mechanical and aerospace engineering.

For the Ph.D. degree in Applied Sciences, both oral and written examinations are given by the student's individual graduate committee after completion of the foreign language requirements which are at the discretion of the student's advisory committee. Instead of majors or minors, the applied sciences program requires proficiency in the area of interest and the area of mathematics, physical and engineering science.

Full-time graduate students are eligible to apply for fellowships, traineeships, assistantships and loans. University fellowships are awarded to graduate students on an all-University basis and are unrestricted as to the student's field of graduate study. Each provides a stipend of $2,800 for the academic year and tuition is remitted. Industry, foundations, and private individuals have donated funds to support a number of fellowships for University graduate students. Teaching assistants receive stipends ranging from $2,800 to $3,300 for the academic year and tuition is remitted. Eighty percent of the full-time students receive some form of financial assistance which mostly consists of research assistantships and fellowships. Sixty percent of the full-time students receive research assistantships or fellowships; twenty percent receive teaching assistantships; and twenty percent support themselves.

CURRENT FACULTY, STUDENTS, GRADUATES

Four full-time faculty members contribute to the teaching of the program's curriculum. Two post-doctorates are involved in full-time research. Most of their research funding is for wastewater research.

Current enrollment (Fall, 1977) in the master's program is 14 full-time and 15 part-time students. Only one of the full-time students and four of the part-time students are female. Most of the graduate students spend two years in residence to complete the requirements for the degree. The enrollment in the M.S. program has remained constant over the last few years. Total enrollment in the program is currently 30 (including one Ph.D. candidate).

It is estimated that 6 M.S. students and 1 Ph.D. annually receive degrees on the average. It is estimated that 70 percent of the graduates find private sector jobs (40% consulting, 30% industry). Some find positions in chemical engineering, mobile environmental engineering, and research; consulting jobs have been found in organic recycling of wastes. Also, a few students have obtained positions at Dupont which is located nearby. One part-time student holds a position as head of environmental engineering at Aberdeen Proving Ground. A smaller percentage of graduates (30%) hold academic or governmental positions. Some of the part-time students are administrators of local environmental agencies and take additional coursework. Also, some of the part-time students are degree bound. An advantage to part-time students is the fact that all of the graduate course offerings in the program are offered at 4:30 P.M. or later.

PROGRAM PROJECTIONS

It is not anticipated that the program will significantly increase in enrollment or structure in the next few years. Because of the multi-disciplinary nature of the program, additional faculty members can be recruited to teach courses in other areas of interest.

COURSE DESCRIPTION (SELECTED)

GEO 601 Environmental and Applied Geology - The application of geologic principles to matters of environmental concern. (2 s.h.)

CE 331 Introduction to Environmental Engineering - An introductory course in which the student is exposed to interactions within the environment and to the associated engineering problems. Discussions of air and water supply, wastewater treatment, solid wastes, industrial wastes, and their effect on the environment. (3 s.h.)

CE 431 Design of Environmental Control Facilities - Concepts of chemistry, biology, and engineering applied to design of systems for collection, transportation, and treatment of water and wastewater; introduction to water and air quality of criteria; stream pollution. (3 s.h.)

CE 443 Water Resources Engineering - Study of the development, use and allocation of water for irrigation, navigation, flood control, hydropower, water supply, conservation and recreation. (3 s.h.)

Graduate courses:

CE 630 Environmental Health Engineering - Broad application of engineering principles to environmental problems. (3 s.h.)

CE 633 Physical Aspects of Environmental Engineering - Physics of particulate matter in air and water. (3 s.h.)

CE 635 Air Resources Engineering - Air pollution - its causes, effects on environment; and control. (3 s.h.)

CE 637 Water Quality and Pollution - Water quality standards and criteria for various beneficial uses of water. (3 s.h.)

CE 831 Theory of Water Treatment - Application of chemical, biological, and engineering techniques to water treatment processes; aeration, sedimentation, filtration, disinfection, control of taste and odors, etc. (3 s.h.)

CE 832 Theory of Wastewater Treatment - Composition of wastes. Treatment and disposal of sludges produced at wastewater treatment plants. (3 s.h.)

INSTITUTION: UNIVERSITY OF GEORGIA

PROGRAM: Environmental Health Science

DEPARTMENT: Dairy Science

DEGREE: Bachelor of Science in Environmental Health (B.S.E.H.)

CONTACT: Dr. Harold Barnhart, Chairman
Program in Environmental Health Science
University of Georgia
Athens, Georgia 30602
(404) 542-2454

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This multidisciplinary program was organized in 1970. Students receive training which prepares them to be examined for state certification as sanitarians. Environmental health scientists are in demand by governmental agencies, private industries and institutions. Opportunities for employment exist in various specialized programs within public health agencies in such areas as food and milk technology, solid waste management, vector control, general sanitation engineering and pollution control. Environmental scientists are employed in programs of water and air pollution control, quality control, industrial hygiene and a variety of other activities by a significant number of agencies and commercial concerns. This program is non-accredited.

The program makes use of the faculty and special facilities of many departments, particularly those of Entomology, Microbiology, Dairy Science, Poultry Science, Agricultural Engineering, and Food Science. During the first two years, students follow the general core curriculum for the Bachelor of Science for Agriculture. Within the Georgia university system, students may not declare a major until they have completed their sophomore year and they must declare one prior to their junior year. Each specified Environmental Health Science course is accompanied with a detailed course outline for the students.

PROGRAM REQUIREMENTS

Those people wishing to enter the freshman class should have taken college preparatory high school subjects, which include English, mathematics (at least one year of algebra), science, history, and a foreign language. Students who have had a foreign language for two years are required to take the College Board Achievement Test in that language. The College Entrance Examination Board's

Scholastic Aptitude Test and Mathematics Achievement Test are required of all freshman applicants.

The general core curriculum which freshman and sophomores in the College of Agriculture are required to take is composed of twenty quarter hours of course work in the humanities; ten of these are in English, twenty hours in the mathematics and natural science area, twenty hours in social science, and thirty-five hours of courses which are related to the major. Related courses include ten hours of biology, botany or zoology; five hours of statistics; five hours of physics; five hours of graphics; five hours of chemistry; and five hours of physical education.

At the beginning of their junior year, Environmental Health Science students begin work on the major requirements and electives. Seventy quarter hours of designated coursework in the six departments which are involved are required. Students are given a list of thirty-seven suggested courses which are environmentally related for fulfillment of the thirty hours of electives required; however, students are not restricted to these listed courses.

Cooperative education opportunities exist with the Environmental Protection Agency Air and Water Surveillance Laboratory in Athens, Georgia. Students recieve pay for their work. Additional financial support is available on a competitive basis in the form of six departmental scholarships. Other coop opportunities may be developed as need arises.

CURRENT FACULTY, STUDENTS, GRADUATES

One full-time person coordinates and teaches the five courses which are specified environmental health. Faculty from six distinct departments teach twenty major courses out of which students select twelve. Certain of these faculty provide additional support in an advisory capacity to the coordinator.

There are seventy-five students enrolled full-time, 88 percent of whom are Georgia residents. Twenty-five to twenty-seven people graduate year on the average. It is felt that this program will have reached its ceiling when the enrollment increases by fifteen students. Many times due to space limitations laboratories which were designed to accomodate twelve students must serve as many as twenty-five students at a time; space is a critical problem.

Even though efforts were made to follow-up on graduates of the program, information is limited due to poor response to the questionnaire which was sent. An official estimates, however, that 20 percent of the graduates seek advanced degrees, 30 percent work in governmental positions, and 50 percent are employed in the private sector.

PROGRAM PROJECTIONS

No real changes are foreseen for this program. There is no faculty growth anticipated and no increase in the space allotted, two aspects where need has been identified. The maximum growth in enrollment which can be permitted is by fifteen students.

COURSE DESCRIPTION

Sample of major courses:

ENT 477 Chemistry and Toxicology of Insecticides and Fungicides - A study of the biology, use and impact of insecticides and pesticides in agriculture and their chemistry in the environment. (5 q.h.)

EHS 459 Microbiology of Water and Wastewater - In-depth study of microbial life of water and wastewater, domestic and industrial, with scrutiny of current treatment processes. Sampling methods will be demonstrated along with proper storage of samples. Study made on the effects of different types of waste on microbial population of rivers and streams. (5 q.h.)

MIB 350 Introductory Microbiology - A survey of microorganisms with special emphasis on bacteria and their relationship to man. (5 q.h.)

ENT 374 Agricultural Entomology - Introduction to entomology. Recognition and control of insect pests of crops and animals. Designed for non-entomology majors. (5 q.h.)

ENT 376 Medical Entomology - Introduction to entomology. Species of insects and related arthropods of particular importance in cause or transmission of disease. (5 q.h.)

FS 407 Microbiology of Foods - Microorganisms in natural and processed foods; their origin, nature, and effects on foods; enumeration; relationship to health. (5 q.h.)

FS 421 Environmental Microbiology - Role of environment on organisms; agents to retard, inhibit, or stimulate bacteria and their mode of action; dynamics of physical, physiological and chemical agents; isolation of anaerobes and factors affecting sporogenesis, dormancy, spore germination and differentiation. (5 q.h.)

DS 411 Microbiology for Sanitarians - Study of microorganisms in fluid milk and milk products, their relation to spoilage and epidemiology. Inspection and enforcement procedures. (5 q.h.)

DS 350 Dairy Chemistry - A basic study of the chemical and physical properties of milk; analysis of milk and milk products according to standard methods. Functions and operation of a dairy control laboratory. (5 q.h.)

AGY 464 Soil for Multipurpose Use - Soil as an important part of our natural resources with emphasis on genetic properties which influence the soil's use for non-farm purposes. Principles involved in developing and managing soils for a quality environment. (5 q.h.)

Samples of suggested electives:

AEN 448 Instrumentation for Environmental Quality - Basic principles of operation of instrumentation used to measure physical variables which determine environmental quality. (5 q.h.)

ECN 402 Economics of Natural and Environmental Resources - Analysis of economic and physical prinicples underlying use of natural resource base. Economic sources of environmental problems. 5 q.h.)

BIO 350 Ecology - Biotic populations and communities. Population structure and dynamics, organization and classification of communities, nutrient and energy flows in ecosystems, and principles of systems ecology. (5 q.h.)

GLY 302 Mineral Resources and the Environment - Historical influence of mineral resources. National and international policy. Mining and petroleum industry. Depletion allowances. Conservation vs. mining. Sufficiency of mineral resources. (5 q.h.)

INSTITUTION: UNIVERSITY OF KANSAS

PROGRAM: Environmental Health Engineering; Environmental Health Science

DEPARTMENT: Department of Civil Engineering

DEGREE: Master of Science in Environmental Health Engineering
Master of Science in Environmental Health Science
Doctor of Philosophy in Environmental Health Engineering
Doctor of Philosophy in Environmental Health Science

CONTACT: Dr. Ross E. McKinney
Environmental Health Program
4002 Learned Hall
University of Kansas
Lawrence, Kansas 66043
(913) 864-3731

PROGRAM DESCRIPTION:*

PROGRAM STRUCTURE

The graduate programs in Environmental Health Science and Engineering at the University of Kansas emphasize that our environmental pollution problems demand a variety of approaches and ideally a training appreciation for both science and engineering. From its inception at the M.S. level in 1961 and the Ph.D. level in 1965, the Environmental Health curriculum has encouraged close faculty-student interaction on research projects of mutual interest. The faculty have chosen to develop a "quality" program producing a select group of graduates rather than a "quantity" program producing many.

Primary areas of research are the technical and social aspects of air and water pollution control, water quality, and solid waste management. Currently, the program receives training grants in water from the Environmental Protection Agency (EPA), EPA research support in wastewater treatment, industrial support, and municipal contracts that permit on-the-job training for students. A close working relationship with the EPA regional office in Kansas City is maintained, and students have used EPA facilities in conjunction with thesis work. Research funding presently totals $70,000.

The Environmental Health programs are currently housed in the C. L. Burt Laboratory which has the instrumentation necessary to perform all of the analytical measurements usually associated with research investigations in water quality. Air quality instrumentation is being developed. A roof deck to accommodate outdoor experiments is available as are the following major pieces of equipment: infrared, visible, ultraviolet, atomic absorption, and gas-liquid spectrophotometers; carbon, hydrogen, nitrogen, and oxygen analyzers for solid materials; Warburg and continuous-flow automatically recording respirometers; four constant temperature rooms; automatic titrimeter;

torsion balances; remote location automatic water sample collector; polarographic and galvanic remote location dissolved oxygen analyzers; Meloy labs SO_2 monitor and hydrocarbon analyzer; mast ozone and nitrous oxides meters; Beckman infrared carbon monoxide monitor; and Hi-Vol particle sampler.

Completely equipped microbiology and hydraulics laboratories and computer and library facilities are also available. Study and research space are utilized in Moore Hall, the new home of the Kansas State Geological Survey. The regional office of the Water Resources Division of the U.S. Geological Survey is located on campus and provides a readily available source of basic hydrologic and chemical water quality data. The Environmental Health and Water Resources programs, both located in Learned Hall, are closely coordinated.

The department conducts three two-day workshops on special topics for people in industry and this year sponsored its 28th Sanitary Conference (regional) for consulting engineers, state agencies, EPA personnel, and municipal employees. The workshops and conferences are designed to address specific, regional concerns.

The current emphasis of these University of Kansas programs is perhaps best described by Professor Ross E. McKinney:

> Currently, the Environmental Health programs start with foundations on chemistry and biology and build through the fundamental principles of the physical, chemical and biological processes that are used to develop solutions to problems in air pollution, solid wastes, wastewater pollution and water treatment. In addition, the students are encouraged to examine the administrative relationships, the legislation affecting the different areas of environmental pollution control and systems analysis related to both large and small scale problems. Research still forms a major part of the educational experience of many students; but it has been recognized that some students have greater needs for additional course material and lesser needs for the research experience at the M.S. level... Many International students come from areas of the world where the need for improved environments is urgent and the need for new solutions from research has a low priority. These International students need to maximize their technical information base by taking more courses. A Special Problem study on an important technical area of concern to their own country replaces the thesis for International students electing the non-thesis option.

PROGRAM REQUIREMENTS

Admission to the Environmental Health Engineering programs ordinarily requires a B.S. in Civil Engineering, while qualified students who do not have the C.E. degree but who have a baccalaureate degree with major emphasis in physical or biological science may be admitted to work toward a degree in Environmental Health Science. All candidates for the M.S. degree have two options available to them: Option A which requires 30 semester hours including a thesis of 10 hours and a final oral examination defending the thesis, or Option B which requires 33 semester hours including a 3-hour special problem investigation in the area of special interest to the student and a written final examination. The two Environmental Health master's degrees require courses in chemistry, biology, and environmental process concepts.

The Ph.D. Environmental Health degrees require 72 semester hours at the graduate level including those earned for the M.S. degree. A student must spend the equivalent of three full academic years in resident study at the University of Kansas or some other approved institution including the time spent earning the master's degree. Each candidate must complete two basic skills which contribute most to his/her research effort, in addition to those acquired as part of the approved plan of study. Possible basic skills are foreign language, computer skills, mathematical skills, laboratory techniques, or physical and biological science skills.

CURRENT FACULTY, STUDENTS, GRADUATES

There are presently four full-time and one part-time faculty members in the Environmental Health programs. Their time is split between teaching and research, a fact that reflects the departmental philosophy emphasizing close faculty-student interaction in training activities. There are 18 M.S. and 7 Ph.D.s in Environmental Health Engineering and 12 M.S. and 3 Ph.D.s in Environmental Health Science. Approximately 20 students are pursuing degrees on a part-time basis; and a majority of these individuals are engineers employed in either the Kansas City metropolitan area or in Topeka. The Environmental Health program has offered courses through the School of Engineering's evening program for engineers in the Kansas City area who wish to pursue graduate coursework. The high demands on the faculty brought about by student enrollments in both Lawrence and Kansas City have led to Saturday morning or early a.m. courses during the week so that part-time students and regular students can take the classes together. Evening courses have been offered by dual communication television in both cities. According to Dr. McKinney, "the combination of regular students with the part-time students active in practice has produced the added benefit of making the course material more relevant to real world problems that are being faced while the course is being taught."

The program, which has no trouble recruiting students, attracts people from the biological and chemical sciences who want to learn how to solve problems using their undergraduate knowledge. Financial support for students is available through the EPA training grants; research and teaching assistantships; and, of course, through part-time work in state and municipal agencies and consulting firms whose employees are enrolled in graduate education.

Between June 1962 and May 1976, 132 M.S. and 22 Ph.D. degrees in Environmental Health Engineering and 20 M.S. and 5 Ph.D. degrees in Environmental Health Science were awarded. While graduate figures reflect enrollment spurts, approximately 17 M.S. and 1-2 Ph.D. diplomas are conferred annually. Virtually all graduates are employed in their field of training; and roughly 60 percent obtain jobs in the private sector. Former students now work in consulting engineering firms, regulatory agencies (state, regional, federal), sales, industry, operations of large-scale water treatment systems, education, and research. Placement is not a problem in Environmental Health at the University of Kansas, and the department maintains close contact with its graduates.

PROGRAM PROJECTIONS

The needs of the Environmental Health programs are basic: (1) continued training support to maintain the quality of the program for educating people for the scientific and practical work in this field, and (2) periodic funding for instrumentation and equipment necessary to keep pace with changing technology and legislative mandates (e.g., organic trace analysis in wastewater). Faculty stress that funding should not be used merely to increase the numbers of students but must be directed toward sustaining high caliber training.

The future of the Environmental Health programs is summarized well by Dr. McKinney:

> *The Environmental Health programs at the University of Kansas have changed over the years to meet the needs of Kansas, which have mirrored many of the needs of the nation as a whole. Increased concerns are being directed towards air pollution in addition to water quality and solid wastes. The emphasis created by greater public participation and special interest groups in the different environmental issues is producing changes in the course contents. More emphasis is being given to socio-political relationships along with the technical information needed to produce engineering solutions. With more problems developing from poor operation of engineered systems, there is no doubt that further changes will occur in the future . . . The current program is a far cry from the early programs; but it exists because it has been built on those early programs. The future programs will be built on the current program and will reflect the desires of the faculty and the needs of the people.

* Source: Article by Dr. Ross McKinney in Environmental Education in Action II: Case Studies of Environmental Studies Programs in Colleges and Universities Today, edited by Clay Schoenfeld and John F. Disinger (in publication).

COURSE DESCRIPTION

CE 770 Concepts of Environmental Chemistry - Lectures on the application of fundamentals of aquatic chemistry to water purification and wastewater treatment. (2 s.h.)

CE 771 Environmental Chemical Analysis - A three hour laboratory introducing the basic chemical tests used in the environmental health field. (1 s.h.)

CE 772 Physical Principles of Environmental Engineering Processes - Physical principles of suspensions, kinetics, fluid flow, filtration and gas transfer are applied to various environmental physical processes. (3 s.h.)

CE 773 Biological Principles of Environmental Engineering Processes - A basic study of the micro-organisms of importance in sanitary engineering, namely, bacteria, fungi, algae, viruses, protozoa, rotifers, and crustaceans. Emphasis is placed on the reactions produced in dilute nutrient solutions and in mixed microbial systems as occur in natural water and wastes. (4 s.h.)

CE 774 Chemical Principles of Environmental Engineering Processes - Chemical principles of stoichiometry, thermodynamics and kinetics are applied to various chemical processes which have application to the environmental pollution control field. (3 s.h.)

CE 775 Marine Pollution - Marine chemistry and relations to pollution problems. Types of pollution and effects on the environment. Interrelation of the chemical, physical, geological, and biological parameters of the ocean and their interaction with pollutants. Special emphasis on problems of world-wide occurrence, international law, cooperation, and economics. (3 s.h.)

CE 776 Environmental Quality - Water quality requirement for irrigation, navigation, recreation, water supply, and wastewater disposal with emphasis on interrelationships in streams, rivers, and lakes. (3 s.h.)

CE 777 Industrial Water and Wastes - Treatment of water for industrial use with emphasis on chemcial precipitation and demineralization. Source and characteristics of industrial wastes, waste reduction by process change and good housekeeping and waste treatment by chemical and biochemical processes. (3 s.h.)

CE 778 Environmental Legislation - The study of the laws protecting the environment and how this legislation affects the practicing engineer and environmental scientist. (2 s.h.)

CE 779 Radiological Waste Treatment - Discussion of radioactivity, radioactive measuring devices, radiological safety, nuclear wastes, disposal systems and effect on the environment. (2 s.h.)

CE 872 Environmental Health Engineering Administration - Organization and operation of environmental health engineering programs at the federal, state, and local government levels. Laws, ordinances, and regulations for various aspects of sanitation. Statistics and epidemiological control of infectious diseases. (3 s.h.)

CE 874 Air Pollution - A study of air contaminants from all types of sources; deleterious effects of contaminants on plants, animals and materials; determination source strength; basic theory of control devices; air pollution surveys; and organization of control programs.

CE 875 Solid Waste Disposal - Study of refuse collection and disposal with emphasis on system analysis in organizing and operating collection systems, various methods of treatment, and economic evaluation of solid waste disposal problems. (3 s.h.)

CE 876 Wastewater Treatment Plant Design - Application of physical, chemical, and biological principles to the design of wastewater treatment processes for municipal wastewaters. (3 s.h.)

CE 877 Water Treatment Plant Design - Application of physical, chemical, and biological principles to the design of water treatment processes for domestic water supply from surface and groundwater resources and water reuse.

CE 878 Environmental Health Literature - Study and evaluation of the current literature in environmental health engineering. (1 s.h.)

CE 879 Environmental Health Research Seminar - Discussion of environmental health engineering research with emphasis on thesis research. (1 s.h.)

CE 973 Environmental Chemistry II - The chemical and biological aspects of special problems in water and sewage treatment, stream pollution, and industrial waste disposal. (2 s.h.)

CE 979 Advanced Topics in Environmental Health - Study of the latest ideas in environmental health. (2 s.h.)

INSTITUTION: UNIVERSITY OF LOUISVILLE (SPEED SCIENTIFIC SCHOOL)

PROGRAM: Environmental Engineering

DEPARTMENT: Chemical and Environmental Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Engineering (M.Eng.)

CONTACT: Dr. Charles Plank, Chairman
Department of Chemical and Environmental Engineering
Speed Scientific School
University of Louisville
Louisville, Kentucky 40208
(502) 588-6355

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This five year curriculum in environmental engineering began in 1971. The five year approach to engineering curricula plans has been operant for more than twenty-five years. At the end of the fourth year a Bachelor of Science degree is awarded, but this is not intended to be terminal. It is expected that unless the student has low grades (i.e., C- or lower) he/she will continue with the Master of Engineering program which is a post-baccalaureate professional curriculum.

One difficulty officials have encountered is the high employability of the students with B.S. degrees. High salaries make leaving the program following the baccalaureate program extremely attractive. Typical career opportunities exist with the Army Corps of Engineers, the state, and the Environmental Protection Agency. Although there has been no follow-up study conducted, it is believed that greater than 50 percent of the graduates accept positions with governmental agencies.

The Speed Scientific School provides an extensive amount of technical equipment allowing students hands-on experience. In the past this program was so multi-disciplinary that it did not have its own office and its chairman was directing three programs in addition to this one; Environmental Engineering was only marginally identifiable as an entity. This illusive appearance was thought to be the leading cause of sluggish enrollment figures. In 1977 this program was placed under the administrative aegis of the Chemical Engineering Department which was subsequently renamed the Chemical and Environmental Engineering Department. Currently, the chairman is dividing his attention between chemical engineering and environmental education and while the situation is greatly improved, the problem is not solved.

PROGRAM REQUIREMENTS

A student is eligible for admission to the undergraduate engineering programs on the basis of graduation from an accredited high school with at least fifteen standard units of credit of which twelve are academic, not vocational in nature. The twelve credits must be distributed among English, algebra, plane geometry, advanced mathematics, physics, chemistry and the remainder in history, social studies or foreign languages. In addition to those requirements, applicants must submit ACT or SAT scores. If sufficient aptitude is demonstrated, a student will be admitted to the freshman engineering program.

One hundred and twenty-two semester hours are required for a B.S. degree in Applied Science. First and second year students take all their courses in the Division of Pre-Engineering. The first year consists of introductory engineering courses and fundamental courses in chemistry, mathematics, and English. Second year students become more deeply involved in engineering principles course work, and they also decide what their major concentration will be. Students attend school year round. Seventy-four credits are required for completion of the pre-engineering core curriculum.

One of the strongest features of this curriculum is that each student must complete two sixteen-week internships and one eighteen-week internship with industry. These internships begin the summer after the second year of courses and run during the spring semester of the third year and the fall semester of the fourth year with academic quarters in between. The average co-op salaries are nearly twelve thousand dollars per year. Those individuals who successfully complete the program this far are awarded a B.S. degree and have the option of continuing for one more year and earning the M.Eng. degree provided they have a grade average of not less than a C minus.

Students who pursue the post-baccalaureate degree must write a thesis. An M.Eng. requires thirty-eight semester credits, including a thesis, beyond the B.S. degree requirements. Financial aid in the form of one teaching assistantship, five research assistantships, and one graduate service assistantship were received by post-baccalaureate persons.

It is important to note that it is the intent of the professional program that the student complete the entire five year plan culminating with the M.Eng. degree. Also, the M.Eng. degree is a professional degree awarded by the Speed Scientific School, not by the Graduate School of the university.

CURRENT FACULTY, STUDENTS, GRADUATES

There are four full-time faculty and four part-time adjunct faculty in environmental engineering. Approximately half of their efforts are expended on research, and half on teaching.

This program must recruit its students and goes about it in two ways with varying levels of success. Visits to high school science classes in Kentucky have been effective. Another very effective means of recruitment is a program called 'Department Days'. The Speed Scientific School features orientations to the various engineering concentrations during which time a potential major has the opportunity to visit four departments. This mode of recruitment is most effective among the students already enrolled in the pre-engineering curriculum.

Twenty-six third and fourth year students are currently pursuing the B.S. degree. There are an estimated thirteen people graduating each year with B.S. degrees. Fourteen people are enrolled full-time in the post-baccalaureate program with six M.Eng. degrees awarded in 1977.

Students appear to have good results in locating employment through the Placement Office, but the majority of the placements are made through personal associations established during internships. There has been no systematic follow-up of graduates to date; however, an estimate indicates that greater than 50 percent of the graduates of both levels find employment with the government.

PROGRAM PROJECTIONS

This program has just undergone a major upheaval and the chief concerns now are for program stabilization, healthy enrollment figure increases, and the establishment of an identity. A program official also felt a priority should be to establish firm ties with industrial concerns.

COURSE DESCRIPTION

Undergraduate courses:

11.300 Man and His Environment - Environmental ecology, water quality control, air quality control, solid wastes disposal, noise pollution, health effects of pesticides, and environmental laws and regulations. (3 s.h.)

11.302 Bio-Organic Chemistry - Biological aspects of organic chemistry as applied to environmental phenomena. (4 s.h.)

11.320 Atmospheric Pollution - Classification of industrial, automotive, domestic wastes and their effects on humans, livestock, plants, and materials. (3 s.h.)

11.321 Air Quality Measurement and Control - Methods of ambient and source sampling. Equipment and methods for pollution control. (3-4 s.h.)

11.330 Principles of Water and Wastewater Treatment - Theory of water and wastewater treatment with emphasis on physical, chemical and biological treatment methods and equipment. (3 s.h.)

11.331 Water Supply and Sewerage - Design, maintenance, construction and operation of municipal water supply and sewerage systems. (3-4 s.h.)

11.340 Fundamentals of Solid Waste Collection and Disposal - General aspects of solid waste management, legal and public relations aspects, nature and quantities of various wastes and their sources. (3 s.h.)

11.380 Principles of Environmental Planning - Political, sociological, and economic factors involved in improving environmental quality, techniques of determining needs of community and selection of alternative approaches, discussion of limitations of technology in meeting community health needs. (3-4 s.h.)

11.390 Occupational Health - Recognition, evaluation, and control of occupational hazards. Topics include disease and occupation; physical, chemical and mechanical causitive agents; TLV concept; sampling, analytical and survey procedures; protective equipment; ventilation; and ergonomics, and OSHA regulations. (3-4 s.h.)

11.400 Environmental Chemistry - Principles of chemistry and applications to the environment; generation and control of pollutants, interactions of contaminants with the environment, detection and measurement of pollutants, and treatment methods. (3 s.h.)

11.420 Environmental Meteorology - Thermodynamics and fluid mechanics relative to the transport and diffusion of contaminants released into the environment. Pollution-level forecasting. (3 s.h.)

11.430 Environmental Engineering Microbiology - Biology, microbiology and biochemistry. Activities of microorganisms and their effect on man and his environment. (3 s.h.)

11.440 Solid Waste Collection and Disposal Techniques - Collection equipment, methods and costs, new developments in refuse collection, and transfer methods. Major disposal methods, landfill site selection and design, fundamentals of incineration and composting. Trends in solid waste disposal and recycling. (3 s.h.)

11.450 Special Project in Environmental Engineering - A professional project open to students of demonstrated initiative and competence in self-study. (1-6 s.h.)

11.460 Environmental Noise Measurement and Control - Measurement of general environmental noises, measurement equipment, data collection and analysis, measurement of noises generated by highways, airports, railroads, etc. Effects of noises on quality of environment and on humans. (3-4 s.h.)

11.515 Environmental Health Physiology and Toxicology - Effects of environmental hazards such as toxic chemicals, radiation, air and water pollutants, on the human body. (3 s.h.)

11.520 Theoretical Meteorology and Oceanography - Dynamics and thermodynamics of the atmosphere and the oceans. Numerical forecasting. (3 s.h.)

Post-baccalaureate courses:

11.520 Theoretical Meteorology and Oceanography - Previously described. (3 s.h.)

11.532 - 11.533 Design of Water Quality Control Facilities I, II - Design of water treatment plants, sizing of equipment, application of recent developments. Design of primary and secondary treatment plants, tertiary treatment processes and equipment. (3 s.h. each)

11.534 Industrial Processes and Waste Treatment - Survey of modern industrial processes with emphasis on use, generation, control, and treatment of environmental hazards. (3 s.h.)

11.535 Measurement of Environmental Quality - Laboratory and field methods for analysis of environmental quality: water, air and solid wastes. (3-4 s.h.)

11.536 Laboratory Modeling of Wastewater Treatment Processes - Purposes, procedures, and principles of laboratory feasibility analysis for treatment of municipal and industrial wastewaters. (3-4 s.h.)

11.550 Disposal of Radioactive Wastes - Methods of ultimate disposal of nuclear waste products, selection of methods, site, long and short term safety considerations, costs, possible effects on environment. (3 s.h.)

11.580 Systems Analysis for Environmental Planning - Application of various types of mathematical models to environmental health planning, input data collection, determination of what comprises a meaningful solution, limitation of systems techniques in environmental health planning, linear, non-linear, and dynamic programming models. (3 s.h.)

11.620 Air Quality Engineering I - Covers general aspects of pollution sources, pollutant transport and pollutant receptors. (3 s.h.)

11.621 Air Quality Engineering II - Applications of air quality engineering principles to advanced treatment and control procedures. Legal and administrative control procedures. (3 s.h.)

11.622 Atmospheric Chemistry - Application of chemical principles to reactions taking place in the atmosphere. Emphasizes equilibrium, thermodynamic, and kinetics concepts. Combustion theory. (4 s.h.)

11.623 Atmospheric and Oceanic Diffusion - Statistical theory of turbulence and phenomena related to problems in diffusion and dispersion of contaminants in the atmosphere, oceans, lakes, rivers, estuaries. Urban pollution modeling. Thermal pollution. (3 s.h.)

11.630 Physico-Chemical Treatment of Water and Liquid Wastes - Physical and chemical nature of water and waste waters, and application to treatment and water quality characterization. Parameters and methods for analysis. Conventional treatment methods, e.g., flocculation, carbon adsorption, and advanced techniques, including oxidation, electrodialysis, and phosphate removal. (3 s.h.)

11.631 - 11.632 Water Quality Engineering I, II - Treatment of water for industrial use with emphasis on chemical precipitation and demineralization. Treatment of industrial waste by chemicals and biological processes. (3 s.h. each)

11.640 - 11.641 Solid Waste Engineering I, II - Storage and collection methods, disease relationships, transfer facilities, design and cost analysis of disposal systems. Systems analysis in planning and management of solid wastes. (3 s.h. each)

11.680 Solid Waste Applications of Systems Analysis - Application of systems approach to planning and design of refuse collection and disposal systems, including linear and non-linear programming, dynamic programming and simulation techniques. (3 s.h.)

11.681 - 11.682 Environmental Health Planning I, II - Environmental design; research and program implementation; field studies developed in contact with local and state agencies. Quantitative analytical and projective methods applied to environmental planning problems. Development and evaluation of models, prototypes, analogs, and solutions. (3 s.h. each)

INSTITUTION: UNIVERSITY OF MAINE - ORONO

PROGRAM: Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science degree in Civil Engineering in the areas of Sanitary, Soils, Structural, and Highway Engineering
Doctor of Philosophy in Sanitary Engineering

CONTACT: Dr. Willem I. Brutsaert
Civil Engineering Dept.
355 Aubert Hall
University of Maine
Orono, Maine 04473

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Maine's sanitary engineering program since inception during the mid-1960s has been predominantly oriented toward water topics. The unique geographical location of this land-grant institution provides excellent outdoor laboratory opportunities for students interested in either lake or water resources research.

At the undergraduate level, students can take basic sanitary engineering courses which concentrate on the theory, design, and control of water treatment plants and unit process for water, air, and land pollution abatement. Students are also offered courses in both chemistry and microbiology in sanitary engineering. In addition, courses are offered in the areas of hydrology, hyraulics and soils engineering.

Graduate courses are available in water resources, engineering, radiological health, industrial wastes, public health engineering, and design of both water treatment and wastewater treatment plants. All graduate students are required to participate in a sanitary engineering seminar during which current research topics are both individually presented and discussed.

PROGRAM REQUIREMENTS

In order to enter the M.S. program, applicants are usually required to have a B.S. degree in Civil Engineering, from an accredited institution. Prospective applicants who do not meet this requirement may have to take courses for no graduate credit.

For the Master of Science degree, a minimum of thirty semester hours, including thesis credits, is required. All M.S. candidates are required to prepare a thesis as well as complete a minimum of 12 hours (exclusive of thesis) of 200 and/or 300 level graduate course work as a part of the thirty semester hour requirement. The thesis credit amount is a minimum of six hours.

The Doctor of Philosophy degree in Sanitary Engineering emphasizes original research and represents approximately 50 percent of the program beyond the B.S. degree. No more than 30 semester hours of transfer credit is accepted and the degree must be completed within four years of admission to candidacy. The dean of the graduate school appoints the student's advisory committee and the student's major or thesis advisor serves as chairperson. Competence in one foreign language is required and proficiency is determined by a written examination involving translation of technical literature.

Graduate students can obtain financial assistance from such sources as: Department teaching or research assistantships; highway fellowships for State Highway Commission employees; and various other fellowships and scholarships.

CURRENT FACULTY, STUDENTS, GRADUATES

The Civil Engineering Department has a total of 14 faculty positions of which five are concerned with sanitary engineering topics. All five teaching positions are staffed with two sanitary engineers (one with a water chemistry background), one hydrologist, one water resources engineer, and an environmental engineer with a coastal research background. One associate faculty member is director of the Water Resources Center with a special interest in Lake Systems and fresh water quality problems.

There are currently (fall, 1977) fourteen full time students enrolled in the program of whom two are female. Some students have entered the M.S. program with microbiology or geology backgrounds. Normally, an average of five to seven students receive the M.S. or Ph.D. degree annually.

Few students (one out of ten) continue to receive their doctorates at other educational institutions and those that have continued have gone to Purdue among others. Officials have stated that one hundred percent of the M.S. students have found employment and about seventy-five percent have obtained jobs in the private sector, mostly consulting firms. The other twenty-five percent have found public sector jobs with such agencies as the State Department of Environmental Protection, the U.S. Environmental Protection Agency, and various state planning agencies.

PROGRAM PROJECTIONS

The sanitary engineering program at the University of Maine is expected to expand into a broader environmental engineering program with emphasis on the study of coastal and inland waters. The Master of Science in Civil Engineering will allow students to select options in the following areas: sanitary engineering; coastal engineering; hydrology; and water resources engineering. During 1978 two additional faculty members are expected to be recruited for this expansion. One environmental engineer with research backgrounds in coastal processes and estuaries problems will be hired by the fall term of 1978. The other addition will be a sanitary engineer with research expertise in water chemistry and this second person is expected to be hired by the spring term, 1978. Generally, program officials expect environmental programs to stay at a stable level and maintain a status quo. However, the University of Maine program is expected to recruit additional students who are interested in water resources study relating to coastal and inland waters.

COURSE DESCRIPTION

Graduate courses:

200 Applied City and Regional Planning - The practice of city and regional planning and the preparation of regional and urban plans. (3 s.h.)

230 Water Resources Engineering - Development, control, and engineering of water resources systems. (3 s.h.)

240 Radiological Health - Atomic structure, radioactivity, Decay Law, interaction of radiation with matter, sanitary engineering application of radiation and radioactive waste disposal, and other topics. (3 s.h.)

320 Physicochemical Processes for Water Quality Control - Principles of physical and chemical unit operations applied water and wastewater treatment. (3 s.h.)

322 Biological Processes for Wastewater Treatment - Principles of biologic unit processes applied to wastewater treatment. (3 s.h.)

323 Industrial Wastes - Study of the principles and practice of industrial waste treatment. (4 s.h.)

324 Public Health Engineering - Subjects include epidemiology, housing, air pollution, radiological health, and others. (3 s.h.)

330 Sanitary Engineering Design I and II - The functional design of a water treatment plant, and in the second part, of a wastewater plant. (3 s.h.)

INSTITUTION: UNIVERSITY OF MICHIGAN

PROGRAM: Environmental Sciences Engineering

DEPARTMENT: College of Engineering (interdepartmental)

DEGREE: Bachelor of Science in Engineering (B.S.E.)

CONTACT: Dr. Jack A. Borchardt
Dr. D.E. Briggs
Environmental Sciences Engineering
College of Engineering
University of Michigan
Ann Arbor, Michigan 48103
(313) 764-6487

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Sciences Engineering program was established in 1971 at the University of Michigan "in recognition of the increasing need for trained and skilled engineers to undertake problem analysis and problem solution for environmental problems which cut across traditional engineering disciplines." Coursework taken in this baccalaureate program ranges from engineering and traditional physical sciences to the natural and social sciences. Within individualized plans of study, students fulfill a program option requirement (21-24 hours) designed to develop a problem-solving proficiency in some area of environmental sciences engineering. Option topics include: air quality, combustion processes, environmental chemistry, land management, noise control and abatement, power generation and distribution, radiological hazards, remote sensing of the environment, urban environmental problems, waste management, and water quality. Job opportunities depend on one's direction of coursework. The interface between engineer and environmentalist served by the environmental sciences engineer (see next page for model) is an important one in our technological society.

The programs interdisciplinary housing within the College of Engineering gives students access to a wide variety of laboratories. Faculty note that funds for equipment maintenance are scarce, but Michigan manages to remain at the vanguard of research inspite of the difficulties imposed by low funding. The program in Environmental Sciences Engineering receives no outside funding and has no grant money. Individual faculty members who participate in this program do receive grant monies for projects conducted under the auspices of their home departments.

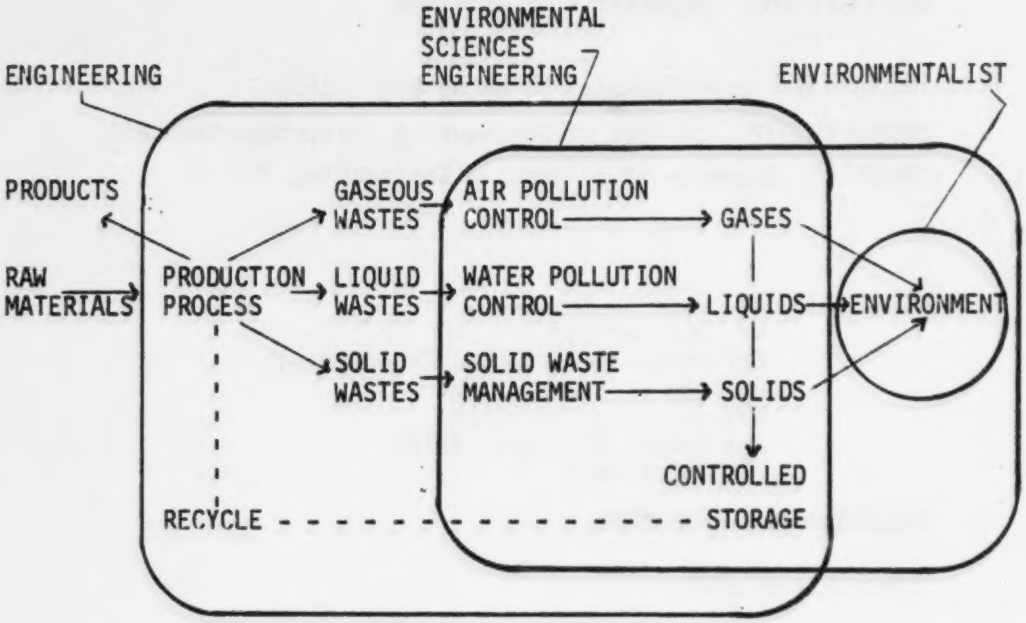

ENVIRONMENTAL SCIENCES ENGINEERING
ENGINEERING
ENVIRONMENTALIST
PRODUCTS
RAW MATERIALS
PRODUCTION PROCESS
GASEOUS WASTES
LIQUID WASTES
SOLID WASTES
AIR POLLUTION CONTROL
WATER POLLUTION CONTROL
SOLID WASTE MANAGEMENT
GASES
LIQUIDS
SOLIDS
ENVIRONMENT
CONTROLLED STORAGE
RECYCLE

Diagram of the Role of the Environmental Sciences Engineer.

PROGRAM REQUIREMENTS

In addition to the Program Option requirements providing the student with some specialization, undergraduate majors in Environmental Sciences Engineering must take a set of College core courses (mathematics, physics, chemistry, humanities), an engineering sciences core, basic environmental sciences courses (chemistry, atmospheric and oceanic sciences, geology, biology), and a senior seminar in Environmental Sciences Engineering. The B.S. degree requires 128 semester hours.

CURRENT FACULTY, STUDENTS, GRADUATES

There are no faculty officially assigned to the Environmental Sciences Engineering program though one person from the College of Engineering does serve as program advisor. As of Winter 1977, there were 79 full-time students enrolled from within the College and by transfer from science and natural resources programs. (In recent years, approximately nine students have entered the program by transfer for every seven entering from freshman status.) Ten to twelve students complete the degree annually with fluctuations due in part to social pressures to study the environment.

In the past, roughly equal percentages of graduates have entered government and private sector jobs; but an influx of consulting firms will undoubtedly upset that balance in favor of the business world. The problem-identification and problem-solution emphasis of the program has not always been well recognized and appreciated by employers; and therefore, the engineering background of the students has often assumed great importance in job placement. Approximately 20 percent of the Environmental Sciences Engineering graduates pursue advanced degrees.

Of the 101 graduates of this program since its inception in 1971, program options (or concentrations) selected were as follows:

Program Option	Number	Number Oriented Toward Civil Engineering
Water and Water Related	52	52
Land	12	12
Waste Management and Control	5	5
Air Quality and Pollution Control	8	
Atmospheric-Oceanic Sciences	6	
Combustion	4	
Environmental Chemistry	4	
Nuclear	4	
Electric and Instrumentation	3	
General Environmental	4	4
Others	3	
	105*	73

* Four students had program options listed under two titles.

PROGRAM PROJECTIONS

The need for financial support for the Environmental Sciences Engineering program parallels that of many such programs. According to faculty personnel, programs built with training grants from industry and government are now floundering unless their home institutions have chosen to absorb their expenses. Nonetheless, this program enjoys strong and stable student enrollment and continues to provide those students with basic engineering skills coupled with a trained awareness of environmental constraints and design solutions.

COURSE DESCRIPTION

Atmospheric and Oceanic Science:

203 The Oceans - Elementary descriptions of the oceans, their characteristics, and behavior; the sea as a world resource and as an influence on civilizations. (3 s.h.)

300 The Atmosphere - Technical survey of atmospheric science designed especially for students studying science and/or engineering. Atmospheric structure and circulation; composition and controlling processes; determinants of climate and climatic change; topics related to human influences on the atmosphere and atmospheric influences on human activities. (3 s.h.)

304 Atmospheric and Oceanic Sciences I - The various aspects of meteorology and oceanography. Emphasis is placed on the geophysical and geochemical origins, composition, structure, and motions of the atmosphere and oceans. (3 s.h.)

305 Atmospheric and Oceanic Sciences II - A continuation of 304, with emphasis on the description and physical bases of geophysical fluid wave motions, and other physical and biological processes, introducing the students to various aspects of aeronomy, meteorology, and oceanography. (3 s.h.)

Civil Engineering:

420 Hydrology I - The hydrologic cycle; precipitation, its causes, distribution, and frequency; snow melting processes; evaporation; transpiration; infiltration; aquifers, well hydraulics; normal and low flows; magnitude and frequency of floods; storm sewer capacities; flood routing; storage requirements for flow augmentation; measurement of river discharge. (3 s.h.)

Engineering:

480 Seminar in Environmental Sciences Engineering - Examination of critical environmental problems related to modern technology, with emphasis on development of practical solutions. The particular problem(s) studied in any given term will be selected to take advantage of the special knowledge and interests of the student, who will contribute to the development of solutions and alternatives by oral and written presentation. (3 s.h.)

INSTITUTION: UNIVERSITY OF MICHIGAN

PROGRAM: Industrial Hygiene and Air Pollution

DEPARTMENT: Environmental and Industrial Health

DEGREE: Master of Public Health (M.P.H.)
Master of Science in Industrial Health (M.S.)
Doctor of Public Health (Dr. P.H.)
Doctor of Philosophy in Industrial Health (Ph.D.)

CONTACT: Dr. Dohrman H. Byers
Department of Environmental and Industrial Health
School of Public Health
University of Michigan
Ann Arbor, Michigan 48104
(313) 764-2594

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

While the programs in Industrial Hygiene and Air Pollution at the University of Michigan both examine the human exposure to contaminants, the former course of study emphasizes the industrial worker's occupational environment while the latter focuses on the general population's total daily exposure to air pollution. Students in Industrial Hygiene are trained in the recognition, measurement, evaluation, and control of occupational exposures to chemical and physical hazards. Courses cover sources of exposure, toxicity of materials, effects of physical agencies, application of legal and professional standards, and engineering and administrative methods of achieving safe working conditions. Students seeking degrees with emphasis in air pollution concentrate their studies in the investigation, evaluation, and control of community air pollution problems; their courses outline sources, nature, properties, and effects of pollutants as well as the patterns of pollution and the engineering and other methods of controlling these.

The applied-science training offered through either the Industrial Hygiene or Air Pollution areas of concentration is characteristically general--specialization within each field comes with one's job experience. All students complete a field course on in-plant studies in which students visit 8-10 industires for one day each and identify the industrial health measures which must be taken to insure occupational safety.

Research in the department includes a contract with the Chlorine Institute and a ventilation study for a private company. The staff recently completed a six-criteria documant for the National Institute for Occupational Safety and Health. Additional funding from industry helps to support student research. The facilities for teaching and research total eight well-equipped laboratories and basic field instrumentation. The department conducts a number of workshops and short courses for industrial and government agency personnel; these include a NIOSH-AIHA sponsored five-day course for non-professional management people to acquaint them with the field and meetings of 30-50 industrial hygienists and industrial physicians from major corporations to discuss mutual problems.

PROGRAM REQUIREMENTS

The Master of Public Health degree (M.P.H.) requires enrollment in the School of Public Health. The course of study may vary from 36 credit hours to 60 credit hours, depending on prior experience and preparation; this represents from two and one-half to five terms as a full-time student at the school. Two or more years of experience in a health-related field subsequent to completion of the bachelor's degree is required for admission to the minimum 36 hour degree program. For students with no prior acceptable experience, the 60 hour degree program is required. For intermediate experience some adjustment in requirements may be made. All students in degree programs in the School of Public Health are required to complete the "core course", which is a series of courses designed to give a basic knowledge of public health methods and practices as well as an overview of the comprehensive aspects of this professional field.

The M.S. degree in Industrial Health allows the student to elect study in industrial hygiene or air pollution. The actual course of study is supervised in the School of Public Health and is comprised of most of the same courses as for the M.P.H. There is no experience requirement for the M.S. program. The student must complete 36 credit hours which usually take two and one-half to three terms. The Public Health "core course" is not required but equivalent study in biostatistics and epidemiology usually is required.

The Doctor of Public Health (Dr. P.H.) and the Doctor of Philosophy (Ph.D.) in the fields of industrial hygiene and air pollution share essentially the same requirements. The master's degree is not required, but all requirements of that degree must be fulfilled to qualify as a doctoral candidate. Students must complete a research project and prepare and defend an acceptable dissertation. The doctoral degrees usually take about three years beyond the master's requirements.

Applicants for any of the above degrees must have completed a bachelor's degree from an acceptable school (3.0 GPA requirement unless special ability or circumstance). A science background is desirable including a course in college-level mathematics, physics, and chemistry (analytical and organic). Some biological science study is helpful.

CURRENT FACULTY, STUDENTS, GRADUATES

There are three full-time faculty in Air Pollution and Industrial Hygiene; but faculty from other areas in the Environmental and Industrial Health department and other departments teach courses in epidemiology, biostatistics, bioengineering, toxicology, computer technology, radiological health, and water quality. Of the forty-five full-time students in Industrial Hygiene, ten are doctoral candidates. Enrollment in Air Pollution is drastically low -- one M.S. and one Ph.D. student. The program growth in Industrial Hygiene due to legislation and job opportunities stands in sharp contrast to the decline in the Air Pollution area due to minimal availability of student financial aid. The program graduates an average of twenty students annually with yearly fluctuations attributed to the one-year time frame taken by M.S. students compared with the two-year residence required to complete the M.P.H. The number of graduates is increasing slightly despite the University's "no-growth" policy for achieving optimum levels for facilities, student-faculty ratios, and overall quality, not quantity.

Virtually all students are employed in the field with 90 percent taking jobs in the private sector. Salary inequities between government and private-sector positions have contributed to a growing shift away from public jobs, except for those students with a "social conscience", according to department personnel. Employment opportunities exist in government at all levels, industries with air pollution problems, consulting firms, and universities. Financial assistance to 15-16 students comes mostly from a NIOSH training grant, and some from industrial grants, the Environmental Protection Agency, and the university.

PROGRAM PROJECTIONS

Manpower needs in Industrial Hygiene will assure the employability of graduates with this specialization for the next decade or so. The Department is presently searching for two additional faculty-- one engineer or chemist for Industrial Hygiene/Air Pollution and one physician (M.D.) for Occupational Medicine. The increase in non-medical faculty from three to four has been approved. To comply more nearly with school policy, the program will be limiting enrollment to a total of about 35 and scaling down present levels over a two-year period. No major curriculum changes are expected.

COURSE DESCRIPTION

Environmental and Industrial Health courses:

500 Environment and Health - Environmental factors affecting health and disease and major related principles of sanitary science employed in modification of the environment for the promotion of health. Primarily for students other than those majoring in environmental health. (2 s.h.)

501 Environmental Physiology - The effect of environmental stresses on human physiology. Mechanism of production of disease through toxic materials in air, food, and water. Physical variants of temperature, air pressure, electromagnetic energy, and vibration in the production of disease states. (2 s.h.)

502 Principles of Environmental Health - Principles of engineering and science used in the control of man's environment. Includes water supply and treatment, sewerage, wastewater treatment, plumbing and cross connections, swimming pools and bathing areas, refuse collection and disposal, industrial hygiene, ventilation, noise, illumination, community air pollution, radiological health principles, food and milk sanitation, insect and rodent control, housing. (3 s.h.)

504 Computer Applications in Environmental Health - Introduction to data processing, information storage and retrieval systems, and computer programming of environmental health problems.

508 Radiation in the Environment - The biological effects of radiation as a basis for radiation protection standards. Principles and methods of protection against radiation hazards, with emphasis on natural and man-made sources of radioactivity. A comparison of radiation with other toxic agents in the environment. (2 s.h.)

511 Equipment Sanitation Standards, Design, and Evaluation - Principles of sanitation and design, selection of materials, and construction of equipment, such as employed in processing, vending, and dispensing of food; swimming pools and other installations; technical methods of evaluation--bacteriological, physical, chemical, thermodynamic, radioactive, hydraulic; development, implementation, and administration of national standards for industry and local and state regulatory agencies.

512 Environmental Health Administration Practice - Modern concepts, scope, and objectives of environmental health practice. Responsibilities of personnel. Determination of community environmental health problems and needs. Program planning, emphasis, and evaluation. Principles, content, methods, and tools. (2 s.h.)

513 Advanced Environmental Health Administrative Practice - Administration of environmental health programs and organizations. Organizational structure, forces of management, administrative controls, personnel and financial management, legal aspects. (2 s.h.)

517 Environmental Health in Developing Areas - Designed primarily to give individual attention to small groups of foreign students with specific problems in the technical and administrative practices of environmental health. (2 s.h.)

521 Environmental Planning - Constructs an analytic framework within which environmental (health) policy and planning are evaluated. Emphasis on the design and concept of social cost and pollution damage functions and their economic, social, and health implications. (3 s.h.)

531 Environmental Chemistry - Integration of selected principles in physical, organic, and biological chemistry to the study and control of the human environment. Emphasis to demonstrate the underlying difference and unity among various environmental phenomena. (3 s.h.)

533 Fundamentals of Instrumental Methods of Chemical Analysis - Fundamental principles, operation, application of modern instruments in scientific analysis. Instruments include emission, ultraviolet and infrared spectroscopy, X-ray emission and diffraction, gas chromatography, mass spectroscopy, and others. Emphasis on application to environmental and medical fields. (3 s.h.)

541 Essentials of Toxicology - Biological response of man and experimental animals to toxic compounds and factors which influence this response. Detoxication mechanisms. The toxicity of selected groups of chemical compounds. (2 s.h.)

542 Industrial Toxicology - Continuation of EIH 541. Topics include mechanisms of selective toxicity, toxicity and metabolism of aromatic compounds. The relationship of chemical structure to biological activity. (2 s.h.)

543 Ecological Toxicology - Dynamics of toxic substances in the environment. The effects of toxic substances on individuals, populations, and communities of organisms presented in an ecological context. (3 s.h.)

544 Methods in Toxicology - Methods of evaluating acute and chronic toxicity of solids, liquids, and vapors. Techniques of establishing controlled exposures to toxic materials. Directed individual investigations of the toxicity of assigned materials. (3 s.h.)

551 Principles and methods of Industrial Health - Organization of industrial health services in government and in industry. Public health approach to industry. Representative industrial health situations. For public health administrators, sanitary engineers, sanitarians, nurses, educators, and others. Primarily for students not specializing in industrial health. (2 s.h.)

560 Principles of Community Air Pollution - Discussion of economic, nuisance, and health aspects, emphasizing sources, causes, effects, control measures, and the organization and administration of community control programs. (3 s.h.)

561 Health Factors in Air Pollution - Acquaints the student with relationships and applications of physiology, toxicology, epidemiology, bacteriology, and radiation to the field of air pollution. (3 s.h.)

606 Environmental Health Seminar - Seminar reading and discussion in the broad and specialized areas of environmental health. (1-2 s.h.)

650 Industrial Hygiene - Basic concepts of industrial hygiene and occupational health hazards. Physical and chemical stresses of the industrial environment; sources; effects, measurement, evaluation, and control of exposure. (3 s.h.)

651 Industrial Hygiene Control - Control methods other than ventilation for conservation of industrial health, such as substitution and personal protection, with reference to special operations and industries. (2 s.h.)

652 Air Sampling and Analysis - Laboratory and field methods and equipment for appraisal of occupational environmental conditions. Such procedures are related to dusts, fumes, vapors, gases, mists, noise, odors, illumination, temperatures, and humidity. (2 s.h.)

653 Industrial Hygiene Sampling and Analysis - A continuation of EIH 652 with inclusion of analysis of biological specimens. (2 s.h.)

659 In-Plant Studies - Practicum experience centered around trips to industries (8-10) and evaluation of industrial hygiene problems and solutions. (2 s.h.)

660 Sampling Methods in Air Pollution - Familiarizes the student with various instruments and techniques for determining amount and nature of air pollutants in stacks and in the community, together with application of these methods. (3 s.h.)

662 Air Pollution Seminar - Special assignments concerning evaluation and control of air pollution problems. Second term (EIH 663) is a continuation of first term. (2 s.h.)

665 Analysis of Air Pollutants - Principles and methods of operating automatic field and laboratory instruments and of chemical analyses of air pollutants; laboratory exercises using representative instrumentation and selected analytical methods. (3 s.h.)

666 Air Pollution Chemistry - Second half, E.H.: the physical-chemical theory, and application of analytical processes for the determination of air pollutants and their reactions in the natural environment. Systems for the analysis of trace metals and organics. Theory of interaction in light and air pollutant molecules for continuous monitoring. (3 s.h.)

862 Advanced Seminar in Air Pollution - Assignments in depth of problems associated with air pollution. Selected guest discussion leaders. For pre-doctoral students. (1-2 s.h.)

INSTITUTION: UNIVERSITY OF MINNESOTA

PROGRAM: Environmental Health

DEPARTMENT: School of Public Health

DEGREE: Masters of Public Health (M.P.H.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Mr. Rexford D. Singer
1160 Mayo
University of Minnesota
Minneapolis, Minnesota 55455
(612) 373-8080

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

In 1935, health officers of adjacent states selected the University of Minnesota to train public health personnel under provisions of the Social Security Act. Curricula for the training of health officers and public health engineers were established at that time. The mission of the School of Public Health is to provide the interrelated functions of education, research, and service in order to promote the public welfare.

The decision to apply directly to the School of Public Health for study toward a professional degree (M.P.H.) or to the Graduate School for study toward an academic degree (M.S., Ph.D.) will depend upon the applicant's chosen program of study, long-term career needs and expectations, prior experience and academic preparation, and future academic plans.

The student may obtain specialized training in air pollution, public health biology, institutional environmental health, occupational health and safety, radiological health, or water hygiene.

PROGRAM REQUIREMENTS

Applicants for the M.P.H. degree should possess a graduate degree from an acceptable institution in a discipline relevant to public health or a Bachelor's degree from an acceptable institution with a minimum of two years appropriate professional experience. Three letters of recommendation are also required.

Programs of study leading to the M.P.H. degree are offered in 12 areas, one of which is environmental health.

A program of study and research leading to the M.S. or Ph.D. degree, administered through the Graduate School, may be elected with a major or minor in environmental health. These programs are designed for those who lack prior professional experience or those planning a career in teaching or research.

Appropriate course work is selected by the student in consultation with the student's advisor and in accordance with the requirements of the specific program of study. Specialization within Environmental Health include air pollution, institutional environmental health, occupational health and safety, public health biology, radiological health and water hygiene.

Students are expected to take required core courses as a part of their degree program. It also is expected that students will take courses in administration, biometry, epidemiology, and toxicology. Depending on the degree and the option chosen by the student, a thesis may or may not be required.

CURRENT FACULTY, STUDENTS, GRADUATES

The program includes eight full-time and ten part-time faculty members. In addition, lecturers from a variety of industries and agencies participate in the course work.

Approximately 40 new students are admitted to the program each year. Some form of financial assistance is received by 80 to 90 percent of the students. One-fourth of this year's class is female. Student enrollment is 50 full-time and 30 part-time. There are 40 graduates per year.

PROGRAM PROJECTIONS

At some time in the future, the master's program may become more than one year in length and field work may be required.

ADDITIONAL INFORMATION

The University of Minnesota is directing a $2.7 million, five-year grant from the National Institute for Occupational Safety and Health. The University of Iowa, Mayo Clinic, St. Paul-Ramsey County Hospital, and University of Minnesota-Duluth are also members of the consortium.

This grant makes the consortium one of nine centers for the occupational health development among medicine, RNs, industrial hygiene, safety specialists. It is an outreach and degree program which began September 30, 1977. Traineeships will be awarded, industrial contacts developed and equipment purchased.

COURSE DESCRIPTION

Note: Other course work in a wide range of subject areas such as water, wastewater, solid wastes, energy, meteorology, particle technology, noise, law, planning, limnology, ecology, geohydrology, food science, etc., are available to qualified students through other departments and schools within the University including but not limited to Agricultural Engineering, Architecture, Chemical Engineering, Civil Engineering, Earth Sciences, Ecology and Behavioral Biology, Entomology, Environmental Engineering, Food Science and Nurtition, Mechanical Engineering, Law, Pharmacology, Plant Pathology, Public Affairs, Radiology, and Soil Science.

5155 Environmental Health - Methods of promoting man's health by controlling environmental factors relating to air, water, food, wastes, accidents, housing, radiation, industrial hygiene. (4 q.h.)

5159 Seminar: Environmental Health - (arr. q.h.)

5161 Administration of Environmental Health Programs - Administrative organization of environmental health activities. (3 q.h.)

5171 Environmental Microbiology - Survival, dissemination, transportation, and significance of microorganisms in the environment; application of principles to environmental health problems. (3 q.h.)

5177 Public Health Biology - Introduction to plant and animal forms important in environmental health; biological aspects of water supply, waste treatment, stream pollution, and special phenomena related to human disease transmission. (3 q.h.)

5180 Topics in Air Pollution - Selected readings in air pollution with discussion based on these readings. (cr. arr.)

5181 Introduction to the Air Pollution Problem - History, sources, controls, effects, surveys, legal aspects, administration of programs. (3 q.h.)

5182 Air Pollution Controls and Surveys - Public health engineering approach to air pollution controls and surveys. (3 q.h.)

5183 Problems of Air Pollution Control - Special supervised studies involving laboratory and field investigation procedures; review of pertinent literature. (arr. q.h.)

5184 Air Analysis - Laboratory and field exercises involving air flow calibration, dynamic calibration of field equipment for analysis of air contaminants, respirable mass sampling, dust counting and sizing, and instrumentation for measuring physical environmental stresses. (3 q.h.)

5185 Air Analysis II - Laboratory and Field exercises involving sampling and analysis techniques for stack sampling and for ambient air monitoring. Group surveys of air pollution problems and special projects. (3 q.h.)

5190 Topics in Injury Control - Directed readings and reports on selected problem areas in injury control. (cr. arr.)

5194 Occupational Safety - Occupational safety procedures, environmental controls to reduce injuries on and off the job, safety program development and administration. (2 q.h.)

5200 Topics in Radiological Health - Selected readings in radiological health with discussion based on these readings. (cr.arr.)

5201 Measurement and Application of Ionizing Radiation - Introduction to principles of measurement and use of radiative sources; emphasis on health hazards. (3 q.h.)

5202 Environmental Radioactivity - Sources, measurement, evaluation, and control of environmental radioactivity; hazards to general population. (3 q.h.)

5203 Low-level Radioactivity Measurements - Lectures and laboratory on the assay of low levels of radioactivity in environmental samples. (3 q.h.)

5210 Topics in Occupational Health - Selected readings in occupational health with discussions based on these readings. (cr. arr.)

5211 Industrial Hygiene Engineering - Concepts and techniques used in occupational health; emphasis on fieldwork, evaluation of potential hazards, and preventive techniques. (4 q.h.)

5212 Ventilation Control of Environmental Hazards - Theory and application of exhaust ventilation in control of airborne environmental hazards; principles of exhaust hoods, air moving devices, gas cleaning devices; demonstration of measurement techniques; relationship of hazards and process to ventilation design criteria. (3 q.h.)

5213 Public Health Aspects of Toxic Products - Problems of protecting industrial workers and private consumers from useful but potentially harmful products; product testing programs and administration; labeling problems. (2 q.h.)

5215 Applied Occupational Toxicology - Basic toxicology and physiology with emphasis on environmental contaminants. Special consideration of inhalation toxicology of the work environment and air pollution. (3 q.h.)

5232 Environmental Health and Safety in Health Care Facilities II - Ventilation; water supply; plumbing; solid and liquid waste systems; and other environmental engineering problems. (4 q.h.)

5240 Topics in Water Hygiene - Selected readings and discussions of problems relating to the health aspects of water supply and waste water systems. (arr. q.h.)

5241 Environmental Health Aspects of Water Supply - Role of water in human health; physical, chemical, and biological characteristics; evaluation of source, treatment, and distribution systems. (3 q.h.)

5242 Environmental Health Aspects of Groundwater Systems - Introduction to groundwater geology, quality, and treatment; well design, construction, and maintenance; special references to public and environmental health problems. (2 q.h.)

5244 Environmental Health Aspects of Waste Water Systems - Role of liquid wastes in human health; physical, chemical, and biological characteristics; evaluation of source, treatment, and disposal facilities. (3 q.h.)

5261 Environmental Toxicology - Application of toxicology to environmental problems; interpretation and evaluation of data, assessment of potential health hazards, and approaches to solution of problems. (3 q.h.)

8150 Research in Environmental Health - Opportunities for qualified students to pursue research in the importance of environmental stresses on human health. (cr. arr.)

8170 Research in Environmental Biology - (cr. arr.)

8180 Research in Air Pollution - (cr. arr.)

8190 Research in Injury Control - (cr. arr.)

8200 Research in Radiological Health - (cr. arr.)

8201 Radiation Dosimetry - Radiant energy absorption in liquids, gases, and solids; absorption in biological systems. (3 q.h.)

8210 Research: Occupational Health - Cr. arr.)

8218 Field Problems in Occupational Health - Guided evaluation of potential occupational health problems; recommendations and design criteria for correction if indicated. (3 q.h.)

8240 Research: Water Hygiene - (cr. arr.)

8260 Research: Environmental Toxicology - (cr. arr.)

INSTITUTION: UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

PROGRAM: Environmental Management and Protection (EMP)

DEPARTMENT: Environmental Sciences and Engineering

DEGREE: Master of Science (M.S.)
Master of Science in Public Health (M.S.P.H.)
Master of Public Health (M.P.H.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Russell F. Christman, Professor and Chairman
Department of Environmental Sciences and Engineering
School of Public Health
The University of North Carolina
Chapel Hill, North Carolina 27514
(919) 966-1171

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Sciences and Engineering is a component of the School of Public Health of the University of North Carolina at Chapel Hill. The school is one of five professional schools in the university's Division of Health Sciences, and is one of nineteen such schools in the U.S. accredited by the Council on Education for Public Health. Graduate study and research in sanitary engineering were initiated in 1921. The program continually expanded and became Environmental Sciences and Engineering in 1962. In addition to Environmental Management and Protection, the department offers graduate instruction and research in four other programmatic areas: Air and Industrial Hygiene, Environmental Chemistry and Biology, Radiological Hygiene, and Water Resources Engineering.

The EMP program focuses on the education of "environmental managers", with emphases on the analysis of environmental problems and the development of operational programs. The educational content includes technical areas, as well as preparation in the concepts and methodologies of environmental management. A major program goal is to prepare professionals who can operate within the common ground shared by scientists, technologists, and decision-makers. The usual degrees offered within this specialty area are the M.S.P.H. and the Ph.D.; however, the M.S. and the M.P.H. are also available to students. The M.P.H. program is accredited by the American Public Health Association. The M.S.P.H. is primarily intended for those students who are preparing for scientific, technical, and managerial responsibilities in municipal, state and federal agencies, or in industry and consulting engineering firms. To pursue similar career objectives, M.S. candidates may place more emphasis on thesis research. Graduates of the EMP program with master's degrees, normally are offered positions which require a generalized technical background and additional skills in planning, assessment, environmental program strategies and administration. Study for the Ph.D. is intended primarily for those preparing for careers in teaching and research, although the degree is becoming increasingly applicable for professional practice.

The department places heavy emphasis on research, and is involved with over seventy separate research and grant contracts in diverse environmental fields. EMP students are provided with the opportunity to do laboratory and field research. Current research interests include applied research in microbiology and aerobiology of the hospital environment, disinfection and sterilization processes, community noise measurement and analysis, rural environmental quality assessment, and human health effects associated with environmental agents. A fully equipped microbiology laboratory is available for research, and cooperative arrangements with several institutions provide support for hospital-based studies. Also, facilities in two government research laboratories for the study of health effects are available for student research. The program has noise measuring equipment which can be used for the measurement of noise from point and general sources.

The department is involved with a number of special programs and has available a wide range of resources. Special programs are carried out in the Water Resources Research Institute, The Institute of Marine Sciences, and the Occupational Safety and Health Educational Resource Center. Faculty also participate in international programs of assistance in environmental research and education for developing countries. Some of the more outstanding facilities of the department include the Ambient Air Chamber Facility, the Wastewater Research Center, the Radiation Biophysics Exposure Facility, an aerosol lab, and limnological laboratories.

PROGRAM REQUIREMENTS

For admission into the department, all candidates must submit at least two letters of academic reference, a statement of career objectives, the aptitude portion of the GRE and transcripts from all institutions attended (the average grade point for all new EMP students in the fall of 1977 was 3.38; the average GRE score was 1164). For doctoral students, a statement of research interests is also required.

Master's students normally come from undergraduate programs with majors in biology, chemistry, or engineering. Students from any undergraduate major are expected to have had basic course work in biology, chemistry, physics, and mathematics through calculus. Increasingly, prospective students have additional preparation in economics and some courses in the social sciences. The master's program is primarily designed as a program of study leading to a professional degree (M.S.P.H. and M.P.H.) for recent undergraduates and for mid-career development.

Students holding only bachelor's degrees who desire the Ph.D. must pursue this degree through the master's degree. Students already holding master's degrees from other schools may be admitted directly or may be required to enroll for a second master's degree. Admission requires the sponsorship by a faculty member who agrees to serve as the student's program advisor. A master's degree in a similar or allied field is normally required for direct admission into the Ph.D. program.

School requirements for the M.S.P.H. include a basic biostatistics course, a basic epidemiology course, and five departmental courses, or fifteen hours, in a field consistent with the program area. M.P.H. candidates must also take basic biostatistics and epidemiolgy courses, health related courses in at least two departments other than Biostatistics, Epidemiology, and Environmental Sciences and Engineering, and three courses, or nine semester hours, in a field consistent with the program area. Programs of study for M.S. candidates are individually designed by the student in consultation with his/her faculty advisor. A minimum of thirty semester hours of credit is required for all master's degrees, and all students pursuing professional degrees must select a topic and develop an acceptable technical report and register for ENVR 392 for at least three credits in the completion of this report. M.S. candidates are required to complete and defend a formal thesis. Master's reports and theses may range from a bench laboratory study to a field-based study. They are presented at the time of the required oral comprehensive examination. The master's degree requirements may be fulfilled in eleven months, but the more usual time period is eighteen months.

There are no formal course requirements for the Ph.D.; a program of study is developed with the student's committee to provide mastery in the chosen field. In addition to the major, doctoral candidates must have a supporting program of at least fifteen hours; a formal minor may be elected. Two courses in a research skill are required, and all course work is examined at the time of a written examination. An approved dissertation must be prepared that is expected to be a significant and original contribution to knowledge. This is presented and defended at a final oral examination. Registration in ENVR 394 for at least three credit hours is required in the completion of the dissertation. Study and research for the Ph.D. degree normally takes three years beyond the master's degree.

EMP students may follow courses of study in either environmental protection or environmental management. Applicants with appropriate job experience are encouraged to select the management track, which is intended for persons who will direct the operations of environmental protection programs in government or industry. Courses are taken in the areas of environmental planning, assessment and administration, policy, law, economics and systems analysis. Students coming directly from undergraduate programs are advised to concentrate on the technical and scientific aspects of health protection and environmental control. These courses emphasize current concepts, technologies and practices, and basic preparation in program planning and management. A specialized program on the institutional environment is also available, which prepares students for administrative and technical positions in environmental control, in health care facilities and related institutions.

CURRENT FACULTY, STUDENTS, GRADUATES

Three full-time and one adjunct faculty members carry out teaching and research responsibilities within the EMP program. All faculty members hold the doctorate degree, with major research/teaching interests in a variety of areas related to environmental management and protection.

During the 1977-1978 term, twenty-one students are seeking master's degrees in the EMP program, as well as one person seeking the Ph.D. The overall enrollment represents a gradual increase over the last ten years. Ten of these students are self-supporting, one has a loan, and the remainder are supported by training grants and assistantships. The number of training grants available to students in the department has reduced substantially in recent years.

Nine persons graduated with the M.S.P.H. degree from the EMP program during the 1975-1976 term. During the following year, thirteen persons received the master's degree, the majority receiving the M.S.E.E. Of these twenty-two graduates, the employment status of nine is unknown, or they had not yet accepted positions at the time of the survey. Six accepted positions with governmental environmental/occupational health agencies, three joined consulting firms (one in Saudi Arabia), three are with hospitals or medical schools as researchers or instructors, and one is pursuing the Ph.D.

PROGRAM PROJECTIONS

The student enrollment in the department and within the specific programs is not expected to increase, as the department is currently authorized to admit only as many students as it graduates. There will be an addition of one faculty member in the EMP program, in the area of resource economics.

A major departmental programmatic change may take place within the year. Under discussion is the development of research and course offerings on the effects of contaminants on human health. As envisioned, such a development would embrace such diverse disciplines as toxicology, medicine, pharmacology, and oncology, and would tackle such subjects as the relationship of water quality to cancer incidence and the effects of air discharges on upper respiratory ailments. How this new emphasis will be incorporated into the current departmental structure is as yet to be determined. A research committee has been developed to study alternatives and to provide recommendations; money is available for several new faculty members; and efforts are underway to secure new research grants in this area.

COURSE DESCRIPTION

Required Courses:

ENVR 212 Planning and Development of Environmental Hygiene - Programs Concepts and techniques in planning, organization, and management. Program development, decision making, methods for achieving administrative ends, field supervision, criteria establishment and evaluation procedures with reference to environmental hygiene programs. (3 s.h.)

ENVR 251 Environmental Protection I - The scientific rationale and technology of the control of semi-public and private water supplies, liquid and solid waste disposal, lighting, the thermal environment and ventilation. First order reactions, the electromagnetic spectrum and fluid mechanic are applied to a series of environmental hygiene problems. (3 s.h.)

ENVR 252 Environmental Protection II - The scientific rationale and technology of the control of chemical and biological hazards in food and the quality of housing. The principles, methods, and interpretation of laboratory and field test for the evaluation of environmental contaminants. The effect of environmental stress on behavior. (3 s.h.)

Recommended Courses:

ENVR 143 Applied Physiology and Toxicology - Physiologic response of the various organs and organ systems of the body to the physical and chemical stresses of the industrial environment. The method of industrial toxicology and the toxicological basis for the Threshold Limit Values. Concentration-Time equivalence, routes of entry, synergism are investigated in the laboratory. (3 s.h.)

ENVR 171 Water Quality Evaluation and Control - Characteristics of water as a resource. Water uses, trends. Water quality concepts, measurements, criteria, problems, pollutants. Water supply and wastewater treatment and disposal systems. Regulation of water quality standards. (3 s.h.)

ENVR 211 Environmental Management - An analysis of decision-making for environmental protection programs including policy development, program implementation and management approaches. Case studies of specific environmental protection problems emphasizing public policy and actions, organizational structure and institutional arrangements. (3 s.h.)

ENVR 215 Environmental Issues and Assessment - Concepts and methodologies for assessing the environmental, ecological and social consequences of technological development. The preparation of environmental impact statements and case studies of specific projects. (2 s.h.)

ENVR 217 Systems Analysis in Environmental Planning - Systems approach and scientific method. Various approaches to system design. Mathematical models. Production, benefit, loss and cost functions. Constrained optimization. Marginal analysis, linear programming. Application of techniques to systems for the management of environmental quality. (3 s.h.)

ENVR 283 Natural Resource Law and Policy - An examination of the law of resource use and development, its administration and underlying policies. Particular attention to water rights law, regulatory law, and natural resource administration. Regulatory aspects of pollution control programs. (3 s.h.)

Other Selected Electives:

ENVR 138 Environmental Virology - Ecological, environmental health and fundamental aspects of virology, with special emphasis on viruses in air, water, and food. (4 s.h.)

ENVR 141 Elements of Air Hygiene - Health aspects of the air from the standpoint of community air pollution. The chemical and physical behavior and the biological effects of air contaminants. Means of controlling air pollution. (2 s.h.)

ENVR 142 Elements of Industrial Hygiene - Problems and control of exposure to occupational diseases and industrial accident hazards, the organizations and function of industrial and governmental services dealing with these problems, the industrial aspects of communicable and non-communicable diseases, the procedures of workmen's compensation plans, and the integration of occupational health services with local health department activities. (3 s.h.)

ENVR 154 Management of the Institutional Environment - The study of the particular environment of hospitals, nursing homes, and related institutions. The application of biological and chemical methods to the identification of problems; the epidemiology and management of environmental factors influencing health in the institutional setting. (3 s.h.)

ENVR 161 Elements of Radiological Hygiene - The physics of ionizing radiations, their interactions with matter, biological effects and principles of radiation protection. (2 s.h.)

ENVR 255 Solid Wastes Management - The changing characteristics of solid wastes, relations to health, resources and land use, costs of collection and transportation. Current and experimental disposal processes and the interactions among water pollutants, air pollutants and solid wastes. (2 s.h.)

ENVR 282 Public Investment Theory and Techniques - A study of new methods of economic, engineering, and governmental analysis in public investment planning. Techniques include those for converting broad community objectives into specific criteria to design public projects, with special emphasis on water resources. (3 s.h.)

ENVR 313 Environmental Health Problems in Developing Countries - Selected problems relating to achievement of social, economic, and technological benefits in developing countries through improvement of the environment. Seminar topics: technical processes and innovation, institutions, modification of values and attitudes, planning and administration (general applications and specific case studies of environmental change). (1 s.h.)

Students are also encouraged to consider:

Political Science 101 - Public Administration

Political Science 213 - Public Administration and Policy Making

Planning 225 - Dimensions of Land Use Planning and Management

Planning 241 - Environmental Planning

INSTITUTION: UNIVERSITY OF OKLAHOMA

PROGRAM: Environmental Science

DEPARTMENT: Civil Engineering and Environmental Science

DEGREE: Bachelor of Science (B.S.), Master of Environmental Science (M.E.S.), and Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Larry W. Canter
Director, Civil Engineering and
Environmental Science
University of Oklahoma
202 West Boyd Street
Norman, Oklahoma 73019
(405) 325-5913

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental science and engineering programs, at the University of Oklahoma in Norman, were established in 1974. Although the major programs are conducted at the graduate level, OU also offers the baccalaureate degree. Undergraduate students receive training in a variety of areas, thus preparing the graduates for occupations which require the skills of the generalist, or for entrance to advanced degree programs. Specialization is emphasized at the graduate level through instruction and research in areas of environmental concern such as air and water resources, environmental analysis and assessment, solid waste management and design and management of urban systems. Industrial hygiene and radiological health complete the areas which are addressed at the graduate level. All programs place strong emphasis on the sciences and mathematics.

Students of the OU environmental science and engineering programs are considered to be highly employable, and government and industry actively recruit these graduates at all levels. Students may delay the pursuit of highed educational degrees, in response to employer overatures. Historically, a preponderance of these graduates have accepted employment in occupations such as: environmental engineer; radiation physicist; hydrographer; water pollution control biologist; water resources engineer; safety engineer; environmental monitor specialist; and pollution control specialist. Graduates of the advanced degree programs were in a position to demand the higher salaries, however.

The environmental science and engineering programs are administered through the College of Engineering which is located in a new six-story building on the edge of the Norman campus. Well-equipped laboratories offer faculty and students the most up-to-date facilities for research and instruction. The laboratories include: structures, soils, models, sanitary, radioisotope and hydraulics. A major research unit of the College of Engineering, is the Bureau of Water and Environmental Research which affords support and cooperation to the environmental science and engineering programs.

One of the most innovative and promising facets of the Oklahoma system of higher education is the Oklahoma Higher Education Televised Instruction System which is referred to as the Talkback Television System. Almost all of the state's major institutions of higher education participate in this program. Students are required to apply and to be admitted in good standing to an institution which is a member of the system. By judicious utilization of the Talkback Television System, graduate students may earn as much as 50% of their degree program from other institutions. The University of Oklahoma is a major participant in this effort. Students in the broadcasting studios and in the receiving centers quickly become accustomed to this innovative educational endeavor. Faculty and students are equally enthusiastic about the system. The capacity for transmitting higher education from the academic centers to remotely located students is unlimited.

PROGRAM REQUIREMENTS

Admission to the environmental science and engineering programs is predicated upon acceptance by the university and by the College of Engineering pursuant to satisfaction of entrance requirements. Students are recruited at the secondary level by the usual university procedures. There is no recuritment program for graduate students, as the university and the college enjoy a reputation of excellence. Competitive applicants for graduate study, therefore, are evaluated by a committee, in accordance with the particular admission criteria.

The Bachelor of Science degree is awarded upon the successful completion of a minimum of 127 semester hours of course work. Completion of the lower division, 65 semester hours curriculum in environmental science includes: Engr. 1112, 2722; and CE 2102, 2111. The upper division curriculum includes: ES 4114, 4313, 4323, 4980/4980; Phys. 2524; Pol. Sci. 4313; a minimum of nine semester hours of approved science electives; a minimum of 12 semester hours of humanistic social studies; and, a minimum of 18 semester hours of approved technical electives.

Requirements for the Master of Environmental Science include at least 32 semester hours of course work, or 26 semester hours and a thesis. At least 16 semester hours must be in the departmental courses at the 4000-level or above. The masters level study is individually tailored to meet the specific needs of the student.

In general, the Doctor of Philosophy degree requires at least 60 semester hours of post-graduate course work and 30 semester hours of dissertation. Although the doctoral programs are individualized according to the specific interests of the student, at least 30 semester hours of science and mathematics, and a research project are required.

CURRENT FACULTY, STUDENTS, GRADUATES

The current faculty responsible for the environmental science and engineering programs, totals nine full-time personnel. Seven members

PROGRAM PROJECTIONS

The OU environmental science and engineering programs have stabilized and significant changes in student and/or faculty composition is not anticipated. Program changes involving course requirements and additional curricula packages are not planned for the near future.

COURSE DESCRIPTION

Undergraduate courses:

ES 4114 Environmental Measurements - Basic analytical techniques of water analysis and treatment; organic and inorganic constituents of water and dewage; chemical unit processes in water treatment. (4 s.h.)

ES 4233 Environmental Engineering II - (Same as Civil Engineering 4233) Concepts of water and dewage treatment. Design problems.

ES 4313 Environmental Science I - Survey of various types of environments (air, water, land, urban, rural, occupational); sources, levels and effects of pollution in these environments; environmental quality criteria. (3 s.h.)

ES 4323 Environmental Science II - Environmental movements, interactions and transfers; movement of specific pollutants; environmental impact and assessments. (3 s.h.)

ES 4980 Environmental Science Senior Research - Intensive research investigation of a special project under the direction of a faculty member. (12 sh.h. max.)

Graduate courses:

ES 5013 Epidemiology and Statistical Interpretation - The statistical tools for properly evaluating endemicity, epidemicity, and control.

ES 5032 Radioisotope Techniques - (Same as Civil Engineering, Nuclear Engineering, Petroleum Engineering 5032). Fundamentals, methods of detection and exercises; radiation protection and isotope application.

ES 5041 Radioisotope Techniques Laboratory - (Same as Civil Engineering, Nuclear Engineering, Petroleum Engineering 5041). Laboratory experiments in safe handling of isotopes.

ES 5053 Radiological Health - Problems associated with radiation, radiation exposure and effects, measurement and protection, and in general treats radiation as a factor of environmental health.

ES 5063 Radiation Protection Engineering - (Same as Civil Engineering 5063). Description and analysis of radiation facilities; accelerators, X-ray, radioactive materials.

of this faculty hold the Doctor of Philosophy degree and all have accomplished research in appropriate fields. All nine are cost-centered.

Enrollment at the baccalaureate level, includes 40 full-time students, of which 77% are male and 23% are female. This total does not include freshmen.

The graduate programs have a total of 170 students currently enrolled. At the masters level there are: 32 male and 10 female part-time students; and, 39 male and 11 female part-time, Talkback-TV students. In total, at the masters level, there are 104 male (70%) and 31 female (30%) students of which 93 or 69% are part-time.

Doctoral students include: seven male and two female full-time students; and, 20 male and six female part-time students. Of the 35 total doctoral students, 27 or 78% are male, and 26 or 74% are part-time.

ENROLLMENT

	full-time				part-time				total			
	#		%		#		%		#		%	
Degree	M	F	M	F	M	F	M	F	F-T	P-T	F-T	M
B.S.	31	9	77	23	0	0	0	0	40	0	100	77
M.S.	32	10	69	31	33	10	70	30	42	93	31	70
TV	0	0	0	0	39	11	72	28				
Ph.D.	7	2	72	28	20	6	70	30	9	26	26	78
									91	119	43	77
					Total				210		100%	

M = male; F = female; F-T = full-time; P-T = part-time.

Approximately 45 total students graduate annually from the environmental science and engineering programs. At the baccalaureate level eight to ten graduate annually. The graduate programs graduate approximately 30 per annum at the master's level, and five per annum at the doctoral level.

Of those students graduating with the Bachelor of Science degree, approximately 5% continue for further education. At the graduate level, approximately 15% of the master's students pursue the advanced degree at the doctoral level. Historically, these students have chosen the OU doctoral program.

Financial aid in various forms is available to students at the University of Oklahoma. Approximately 34% of the full-time students, however, meet tuition obligations through individual means.

ES 5083 Effects of Ionizing Radiation - Chemical and biological effects of ionizing radiation, acute and long term effects of radiation exposure, basis of radiation exposure limits, treatment of radiation injury, etc.

ES 5113 Advanced Environmental Chemistry - Dilute aqueous solutions; interaction of water with rocks and minerals; models of types of interactions and reactions in natural water systems.

ES 5133 Advanced Environmental Biology - Interaction of organisms and their environment, ecosystems, trophic structures, bio-geochemical cycles, food chains, kinetics and synthesis and growth, fresh water marine and terrestrial habitats, development of models of biological systems.

ES 5223 Chemical Aspects of Sanitary Science - (Same as Civil Engineering 5223). Physical and chemical properties of pure water; kinetics and equilibria in water and sewage, basic analytical techniques; inorganic and organic constituents of water and sewage.

ES 5232 Housing, Institution, and Hospital Environmental Survey - A study in depth of the environmental health needs of the community as related to housing and institutions, particularly hospitals.

ES 5244 Water and Waste Treatment Processes and Operations - (Same as Civil Engineering 5244). Pilot studies of design criteria for water and waste treatment plants.

ES 5253 Public Health Administration and Law

ES 5273 Radiological Surveillance, Assay, and Hazard Generation - A laboratory-lecture course concerned with environmental survey and assay, including theory and operation of survey instruments, sampling procedures, data interpretation, monitoring techniques, and emergency procedures.

ES 5323 Biological Aspects of Environmental Science - Presentation of the diversity and importance of disease-producing and nuisance-causing organisms; or organisms involved in solid and liquid waste reduction; their importance in domestic and foreign public health programs.

ES 5500 Public Health Field Practice - (1-8 s.h.)

ES 5603 Environmental Science - Broadly presents the field of environmental health.

ES 5624 Food Protection, Systems and Analysis - Study of milk and food industry and sanitation requirements and enforcement problems.

ES 5653 Industrial Hygiene - Recognition, evaluation, and control of occupational health hazards.

ES 5663 Noise Environment - Principles of noise pollution, characteristics and effects on the environment; noise evaluation; industrial, ES 5663 (cont'd) - community, and transportation noise; control procedures and social and legal implications.

ES 5803 Solid Wastes Systems Planning - (Same as Civil Engineering 5803). Engineering aspects of solid waste disposal by sanitary landfills, composting, and combustion; systems planning in solid waste management; industrial solid waste management.

ES 5853 Bionics: The Design of Biosynthetic Systems - (Same as Industrial Engineering 5853). Systems theory is followed by detailed consideration of important biological functions and physical methods of achieving simulation.

ES 5883 Human Factors in Technology - (Same as Industrial Engineering 5883). Capabilities and limitations of a human operator are evaluated with regard to stresses encountered in industrial, military, and space environments.

ES 5980 Research for Master's Thesis - (1-4 s.h.)

ES 6030 Radiological Safety Programming - May be repeated with change in topic; maximum credit four hours for master's degree, eight hours for doctor's degree. Selected topics in radiological health; nuclear facility siting, electronic product, radiation dosimetry.

ES 6210 Environmental Science Special Topics - Research oriented problems dealing with current topics of special interest in environmental science. May be repeated with change in topic; maximum credit four hours for a master's candidate, six hours for a doctoral candidate. (1-6 s.h.)

ES 6260 Advanced Radiological Health Laboratory - Based on radiochemical determinations of air, food, and water samples; waste disposal; shielding. (2-6 s.h.)

ES 6323 Vector Control and Solid Waste Management - Measures for the abatement or control of arthropods, rodents, birds, and other disease vectors of public health importance. Formulation of pesticides; pesticiding equipment; refuse storage and collection and disposal standards.

ES 6604 Sanitary Design and Water Resources - (Same as Civil Engineering 6604). Water quality standards are established and adjustments required to bring various raw and wastewater to these standards are analyzed and organized treatments are designed.

ES 6613 Water Resource Systems Analyses - (Same as Civil Engineering 6613). Water resource systems are studied in relation to natural and non-engineering restraints.

ES 6971 Public Health Seminar

INSTITUTION: UNIVERSITY OF PITTSBURGH

PROGRAM: Environmental and Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Ph.D. in Civil Engineering

CONTACT: Dr. Joel I. Abrams
Chairman of Civil Engineering Department
University of Pittsburgh
Room 949 Benedum Hall of Engineering
Pittsburgh, Pennsylvania 15260
(412) 624-4141

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil Engineering first started granting degrees in 1846 and fields of specialization are currently offered in Sanitary Engineering, Water Resource Engineering, and Mine Environmental Engineering and Reclamation. Graduates are employed in positions involving water resources, water supply, waste disposal, air pollution and environmental sanitation. Many graduates find positions with consulting engineering firms (including sales) in research, teaching, and governmental agencies.

Work for full-time students and a complete part-time program are strong points of the Master's degree program. Water resources and environmental engineering are specialty areas in the doctoral program and active research is on-going in both of these areas.

The Environmental and Sanitary Engineering program emphasizes research and courses in the following areas:
Chemistry and biology;
Water analysis for water quality control;
Pollution and control of natural waters;
Unit processes and operations applied to the design of water and wastewater treatment plants;
Solid waste disposal;
Disposal of sludges and concentrates;
Economics;
Administration of sanitary engineering facilities; and
Basin studies and regional environmental planning.

The Department's Sanitary Engineering Laboratories have the necessary equipment and instrumentation for determining all the standard wet chemical and microbiological analyses of water and wastewater. Two walk-in incubators and all the latest equipment for the newer sophisticated instrumental techniques are included in these facilities.

PROGRAM REQUIREMENTS

Applications to the graduate program may be considered on an individual basis, but for the applicant who is a recent graduate with a degree from a school accredited by the Engineer's Council for Professional Development (EPCD), admission is granted on the basis of the undergraduate record, and usually an applicant with a B average will be granted admission.

At the undergraduate level, electives are available during the sixth, seventh, and eighth terms to enable a student to pursue an individualized program in the environmental and sanitary engineering area. The Bachelor of Science degree requires completion of 121-123 credits and the undergraduate program is noted for its flexibility in accomodating student interests in environmental and sanitary engineering.

Graduate students prepare a plan of study during their first term and assistance is provided by a faculty advisor. The Master of Science degree is offered with a thesis and a non-thesis option. The thesis option requires completion of a minimum of 24 course credits (eight courses) plus a thesis (six credit minimum). Students electing the non-thesis option are required to complete ten courses for 30 course credits (minimum) and prepare a three credit project. Graduate Preliminary Examinations are given to determine the admission of a marginal case. A Comprehensive Examination is given to all non-thesis program students and to some thesis program students. A Final Oral Examination is given to evaluate the findings of the student's M.S. thesis or project and related course work. Graduate research assistants are required to write a thesis upon recommendation of the advisor and project supervisor.

In order to complete the requirements for the Doctor of Philosophy degree, a minimum of 30 course credits (ten courses) in a major area, a minimum of 18 course credits (6 courses) in a minor area (one or two minor areas, but one outside the Civil Engineering Department), a minimum of six course credits (two courses) in Analytical Techniques, and a minimum 18 credits of dissertation are required. A Plan of Study and Proposal Conference is administered by the faculty advisor and a member of the faculty in the student's major and minor areas of interest. All Ph.D. students take a Comprehensive Examination toward the end of their course work,and the Final Oral Examination of three hours duration is administered by the Doctoral Committee.

A wide variety of financial aid packages are available to graduate students enrolled in the School of Engineering. Fellowships are offered to exceptional students as an unrestricted grant. Traineeships are offered in selected areas and there are usually restrictions on the courses which are allowed to be taken. Tuition scholarships provide for partial or full remission of tuition. Research assistantships are awarded as research contracts and teaching assistantships and teaching fellowships are awarded from department funds for assistance in laboratories, recitation sections, and for other teaching duties.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight faculty members teach the environmental and sanitary engineering courses offered by the Civil Engineering Department. Approximately one-half of their time is devoted to research activities. Funding for research comes from the National Institutes of Health, the Department of Energy (ERDA), the National Science Foundation, and the American Iron and Steel Institute. A joint U.S. Environmental Protection Agency and American Iron and Steel Institute project on industrial wastes will be forthcoming to the Department. Most research work by faculty is in the areas of heavy metals (using biological treatment to remove heavy metals) and in the pollution effects resulting from energy production and conversion.

The Civil Engineering Department has 320 Bachelor of Science students (including 40 female) enrolled in the fall term, 1977 and 35 students (five female) have elected to take environmental and sanitary engineering courses as electives. About 100 students receive the B.S. degree annually.

At the graduate level, there are a total of 220 students (70% part-time) enrolled in the M.S. and Doctor of Philosophy degree programs in the Civil Engineering Department. Approximately 175 are M.S. candidates and 35 are Ph.D. candidates. Of students electing the environmental and sanitary engineering option, 60 are M.S. students (3 female) and 20 are Ph.D. students (one female). Approximately 35 M.S. degrees and three to four Ph.D.'s are annually granted by the department; of these diplomas conferred, about 15 M.S. and 2 Ph.D. degrees are to students participating in the environmental and sanitary engineering area.

About forty percent of the B.S. students and fifteen percent of the M.S. students continue on for advanced degrees. Most students choose to continue their studies at the University of Pittsburgh. There are many part-time students enrolled in the M.S. degree program mainly because of the availability of jobs in the area. Virtually all graduates find employment directly in their field and it is estimated that 80 percent find jobs in the private sector and 20 percent find positions in government. Most finding private sector jobs are found in consulting engineering firms.

PROGRAM PROJECTIONS

It is not anticipated that the program will significantly increase in the foreseeable future as the Civil Engineering Department has completed a growth phase during the past two years. The program is at a plateau phase but greater emphasis may be given to sanitary engineering, laboratory experimental work, mathematical modelling, hydraulic systems, urban hydrology, and urban pollution in subsequent years. It is expected that only one additional faculty member with expertise in mathematical modelling of lakes will be recruited in the next few years.

COURSE DESCRIPTION (SELECTED)

217 Economics of Projects in Environmental and Civil Engineering - Economic theory applied to use and control of project management and evaluation. Case studies from water resource field. (3 s.h.)

218 Planning, Administration, Management and Legal Aspects of Projects in Environmental and Civil Engineering - Administrative concepts of water pollution control and other Civil Engineering Projects at all levels of government. Government planning and construction aid programs for environmental control. (3 s.h.)

240 Hydraulic Engineering - Review of fundamental hydraulics. Hydraulics of flows in closed and open conduits. Hydraulic structures. (3 s.h.)

242 Hydraulic Transport of Solids - Hydraulic transport of solids in pipelines and open channels. Hydraulics of multi-phase flows. Applications in design of slurry pipelines and open channels and sediment transport in natural waters. (3 s.h.)

244 Surface Water Hydrology - Hydrologic cycle as a deterministic and stochastic system; rainfall-runoff relations; hydrograph analysis, frequency analysis and extreme value theory; design applications. (3 s.h.)

245 Groundwater Hydrology - Mechanics of flow through porous media. Darcy's law, potential flow theory, steady and unsteady flow to wells, practical aspects of well design, numerical methods, leaky aquifer theory. (3 s.h.)

250 Sanitary Engineering Biology - The fundamentals of biology and biochemistry are discussed, particularly as applied to natural waters and wastewater treatment systems. (4 s.h.)

252 Water and Wastewater Analysis - Principles and applications of quantitative chemical analyses of water and wastewater. (4 s.h.)

254 Water Pollution of Natural Waters - Natural history of water bodies, characteristics of natural water, ecological principles, sources and effects of pollutants, assimilative capacity, oxygen balance, eutrophication, acid mine drainage, thermal pollution, stream standards, water quality monitoring, basin planning. (3 s.h.)

255 Water and Waste Treatment Plant Design - Step-by-step development of a complete plant design for a hypothetical city. Design will be rational and empirical, not theoretical. Process design, equipment selection, economic evaluation, and plant layout will be emphasized. (3 s.h.)

259 Current Topics in Environmental Resources - Group discussion of selected readings and investigation into events of current environmental interest. (3 s.h.)

265 Advanced Environmental Systems Laboratory - Functional design, simulation, and evaluation of elements of environmental systems. (Var. cr.)

267 Advanced Social and Environmental Systems Analysis - Time series analysis, estimation of recursive systems, the identification problem, estimation of simultaneous equation systems. Environmental application. (3 s.h.)

340 Selected Problems in Water Resources - Applications of theories and principles to various practical problems and current topics in water resources. (3 s.h.)

351 Unit Operations of Water Treatment - Theory of several unit processes and operations as applied to water treatment. (3 s.h.)

356 Solid Waste Disposal - Theory, design and operation of systems for the collection and disposal of solid wastes. Course includes study of composition of municipal garbage and refuse and available collection methods. (3 s.h.)

365 Environmental Assessment - Methodology of technology assessment; environmental impact analysis, environmental indicators and the strategic environmental analyses system; case studies; the 1972-74 SST review. (3 s.h.)

390-391 Sanitary and Environmental Engineering Seminar - Current sanitary and environmental engineering subjects. (1 s.h.)

INSTITUTION: UNIVERSITY OF PITTSBURGH

PROGRAM: Industrial Hygiene and Air Engineering

DEPARTMENT: Industrial Environmental Health Sciences

DEGREE: Master of Science in Hygiene
Master of Public Health

CONTACT: Dr. Edward McGovern
Research Assistant Professor of Industrial Hygiene
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, Pennsylvania 15260
(412) 624-3043

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Industrial Environmental Health Sciences offers specialized academic training in the area of industrial hygiene. The Industrial Hygiene and Air Engineering specialty program was first initiated by the Graduate School of Public Health in 1965 and is a one-year program of study leading to a master's degree for physical or geological scientists or engineers. Graduate students may extend this program to a doctoral degree with emphasis in a selected area of industrial hygiene or air engineering, e.g. industrial hygiene engineering, analytical methods, aerosol physics. Doctoral candidates have adequate flexibility in their program to be able to select courses offered in the School of Engineering, departments in the natural sciences or School of Medicine.

The Graduate School of Public Health has a wide variety of modern research laboratories which include an anechoic chamber and a whole body counter. Further research opportunities exist in the Pittsburgh area in county and state health departments, local industries, and local health and welfare agencies.

PROGRAM REQUIREMENTS

In order to be admitted to the Industrial Hygiene and Air Resources program, applicants must possess a B.S. or A.B. degree in arts, science, engineering, or nursing or an M.D., D.D.S., D.V.M., from an approved school.

The program is offered over three trimesters (September through July) and consists of a total of 36 credits for the master's degrees. Master's students are also required to take six to eight credits of electives (e.g. acoustics, radiation health, water quality management, toxicology, air resources) and write a satisfactory master's essay.

The Industrial Hygiene program during the 1977-1978 academic year offered an internship program for students with no previous work experience. They spend two trimesters full-time in study at the University and two trimesters (6 months) working in a selected industrial setting. Students have been placed on the staffs of local county and state health departments.

The Graduate School of Public Health annually receives a limited amount of funding for general purpose traineeships. Industrial hygiene traineeships are available which provide $1,000 each toward each student's tuition expenses. A variety of support is provided to industrial hygiene students during the 1977-1978 academic year. Of 14 M.Sc. students: eight received support from the National Institute for Occupational Safety and Health; three from the U.S. Environmental Protection Agency; and one each received support from the World Health Organization, the Brazilian Government and the Occupational Safety and Health Administration. Three part-time M.Sc. students were enrolled in 1977-78 and all three were self-supported. Of four doctoral candidates (Ph.D.), one received support from the National Institute for Occupational Safety and Health; one from the MPC Corporation; one from the Thailand Government;and one student had a Graduate School of Public Health fellowship. In sum, nine students were supported by NIOSH (43%) three from the U.S. EPA (14%); two from foreign governments (10%); three were self supported (14%); and one each received support (5%) from the World Health Organization, OSHA, the MPC Corporation and the Graduate School of Public Health.

CURRENT FACULTY, STUDENTS, GRADUATES

Six full-time faculty members teach the program's curriculum in industrial hygiene and air engineering. The program's faculty are involved with a variety of outside sponsored research which includes:

EPA - Ion Chromatography of Aromatic Amines - 9/15/77 - 9/14/79 - $105,

MPC - Preliminary Investigation of Submicron Aerosols in Allegheny Count
10/1/77 - 9/30/78 - $59,515

DeNardo & MacFarland Weather Service - Precipitation Acidity in Rural Areas - 7-1-75 - 99-99-99 - $11,395

Thermal Insulation Manufacturers Association - Determination of Airborne Concentration in Ceramic Fiber Manufacturing Facilities - 5-1-76 - 6-30-99 - $50,499

Owens Corning Mfg. Co. - Determination of Fiber Erosion from Glass Fiber Filters - 2-1-77 - 6-30-99 - $65,527

Thermal Insulation Manufacturers Association - Determination of Airborne Fiber Concentration Due to Utilization of Man Made River Products - 5-1-76 - 6-30-99 - $56,559

There are currently a total of twenty-eight students enrolled in the program and four are female. A total of 15 students (2 female) are enrolled full-time and 10 (2 female) are enrolled on a part-time basis. There are 15 full-time and 10 part-time master's students and three doctoral students currently enrolled (Spring, 1978).

Approximately 15 students receive degrees from the program on an annual basis and the program has been expanding each year to a limit of 16. Very few students continue on for further degrees offered by other educational institutions but some have gone on to other doctoral programs in the University of Pittsburgh.

Virtually all graduates obtain employment in their field and it is estimated that 60 percent find private sector jobs and 40 percent find government positions. The American Industrial Hygiene Association Employment Service has greatly assisted graduates in finding jobs. Recent graduates have found administrative positions as corporate industrial hygienists, in university teaching, and evaluation and control positions in both government and private industry as industrial hygienists.

The program maintains an updated alumni list of graduates and according to the most recent follow-up study conducted of 16 1977 graduates: nine students (63%) found private sector jobs, one with a consulting firm (6%); one found employment with the National Institute for Occupational Safety and Health (government - 6%); one student was self-employed (6%) one was a doctoral candidate in the Graduate School of Public Health (6%); and one student was still interviewing for an industrial hygiene position (6%).

PROGRAM PROJECTIONS

The Industrial Hygiene and Air Resources program is expected to increase to a maximum of 25 students per year over the next few years. Program officials feel that environmental programs will become stronger in industrial hygiene and weaker in both air and water pollution control and abatement. The Graduate School of Public Health needs to expand particularly in the areas of physiology and occupational medicine. Because of an increased demand for qualified industrial hygienists by the job market, one to two additional industrial hygienists are expected to be recruited for the program's faculty within the next two to three years.

COURSE DESCRIPTION

(the following is a partial listing of courses)

IEHS 201 Introduction to Occupational Health The physical and chemical properties and the methods of measurement of industrial environmental hazards are discussed. The course introduces students to the basic concepts of thermodynamics and chemical kinetics and deals with the properties and measurement of suspended particles, gases, toxic materials, heat, noise, ionizing and non-ionizing radiation. 4 cr.

IEHS 203 Industrial Medicine This is a survey course of the clinical and subclinical changes in the individual resulting from the failure of adaptive mechanisms under the stress of unusual environmental demands that may be associated with industrial employment. (1cr.)

IEHS 221 Special Studies in Industrial Environmental Health Sciences Properly qualified students may undertake research for the master's essay requirement with the approval and under the guidance of a member of the staff. (Cr. to be arranged.)

IEHS 225 Seminar in Industrial Environmental Health Sciences Current developments in research areas in industrail environmental health are represented by investigators active in the fields under discussion.

IEHS 261 Analysis of Airborne Contaminants I The laboratory course presents the physical methods of the evaluation of working conditions. Measurement of flow, sampler calibration, dust sampling and analysis, gravimetry, microscopy and respirabel dust sampling are included.

IEHS 262 Analysis of Airborne Contaminants II The laboratory course presents the methods of evaluation of physical stresses in working environments. Measurement of noise, heat, radiation are included. (1 cr

IEHS 264 Properties and Mechanics of Aerosols Static and dynamic properties of aerosols are studies. The topics covered include: rectilinear and curvilinear motion of aerosols, diffusion, impaction, coagulation, behavior in thermal, electormagnetic and electrostatic fields, sampling and estimation methods. (3 cr.)

IEHS 267 Industrial Safety Introduces the student in industrial hygiene to the occupational safety procedures required by the Occupational Safety and Health Act of 1970. (2 cr)

IEHS 269 Principles of Air Resources Introduces the student to the broad field of air pollution. The first half of the course deals with sources, economics, controls of air pollution and micrometeorology. The second half is devoted to atmospheric chemistry. (3 cr.)

IEHS 271 Ergonomics and Work Physiology The course deals with human capabilities and limitations in relation to the intrinsic stresses of muscular and nervous activity and the extrinsic stresses of the environment in which work is performed.(2 cr.)

IEHS 310 Research and Dissertation for the Doctoral Degree This includes doctoral study under the various programs within the Department of Industrial Environmental Health Sciences.(Variable cr.)

INSTITUTION: UNIVERSITY OF TENNESSEE

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Environmental Engineering (M.S.E.E.)
Master of Engineering in Environmental Engineering (M.E.E.E.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. W.L. Grecco
Department of Civil Engineering
University of Tennessee
Knoxville, Tennessee 37916
(615) 974-2503

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering began as an option in the Department of Civil Engineering in 1966. The Master of Science in Environmental Engineering is designed for students whose undergraduate background is other than engineering. The Master of Engineering is accredited by the Engineers' Council for Professional Development and therefore, requires students enrolled in this program to have undergraduate degrees in engineering. The Ph.D. is offered through civil engineering, and doctoral students may elect a major in environmental engineering.

This program conducts a large number of research activities with outside funding amounting to $846,300. The largest single contributor has been the Department of Energy (formerly ERDA) for a study entitled Environmental Aspects of Coal Production in the Appalachian Region. The U.S. Air Force is providing support for studies regarding stormwater runoff.

A substantial amount of specialized research equipment exists for students' use. For water quality analysis, an atomic absorption spectrophotometer, gas and liquid chromatographs, a programmable data analyzer, a scanning ultra-violet spectrophometer, a total carbon analyzer, selective ion electrode meters, and additional turbidmeters, spectrophotometer, fluorometers, pH meters. For air quality analysis, there are suspended particulate samplers, dustfall collectors, an MRI integrating nephelometer for visibility monitoring, a pulsed infrared laser light scattering single particle counter, an ambient particle counter, a gas analyzer for source monitoring of SO_2 and NO_x, specialized unit operations equipment, as well as other sensitive instrumentation.

A large number of specialized instruments is available for laboratory experimentation in water and wastewater treatment research. The library services on the Knoxville campuses are supplied by three major libraries, including a science and engineering library. Combined, they contain in excess of one and one-quarter million volumes.

Graduates of the programs in environmental engineering are qualified for employment as consultants, urban planners, hydrologists, systems analysts, construction managers, county planners, researchers, environmental and civil engineers, and environmental chemists.

PROGRAM REQUIREMENTS

For admission to the M.S.E.E. program, one must have graduated from a recognized undergraduate curriculum. It may be necessary for some articulation work to be done in preparation for certain of the technical courses. The graduate progam leading to the M.E.E.E. degree is available to students who have undergraduate degrees from E.C.P.D. accredited engineering programs. No admissions examinations are required.

All graduate students in environmental engineering must satisfy a primary core curriculum of fifteen quarter hours which consists of: ENVR 4030 or 4530 - Environmental Chemistry, ENVR 5230 or 5301 - Hydrology, ENVR 5561 (or 5501, 5502 or 5513) - Water Pollution Control, ENVR 5600 - Solid Wastes, ENVR 5710 - Air Pollution Control, ENVR 5590 - Seminar. Students must then select a secondary core of concentration from the following five topic areas: water pollution control, water resources, air quality and/or pollution control, environmental science, or environmental management.

The Water Pollution Control core requires the following courses: ENVR 4530 - Sanitary Engineering Laboratory, ENVR 5593 - Advanced Sanitary Engineering Laboratory, ENVR 5501 - Water and Wastewater Treatment Theory, ENVR 5513 - Advanced Water and Waste Treatment Systems, and ENVR 5551 - Water Quality Mangement. The Water Resources core requires ENVR 5230 - Surface Water Transport, ENVR 5301 Stormwater Modelling, ENVR 5310 - Groundwater Transport, and ENVR 5232 - Sediment Transportation.

Air Quality and Pollution Control requires a secondary core of nine quarter hours which may be selected from: ENVR 5501 - Water and Wastewater Treatment Theory I, ENVR 5502 - Water and Wastewater Treatment Theory II, ENVR 5513 - Advanced Water and Wastewater Systems, ENVR 5720 - Air Pollution Particle Collection Theory, and Air pollution Control Device Design. The program in Air Quality and Pollution Management requires the following: ENVR 5720 - Air Pollution Particle Collection Theory, ENVR 5730 - Air Pollution Control Device Design, and ENVR 5700 - Planning and Air Pollution Management.

The program in Environmental Science requires: ENVR 4530 - Sanitary Engineering Laboratory, ENVR 5593 - Advanced Sanitary Engineering Laboratory, ENVR 5501 - Water and Wastewater Treatment Theory I or 5502 - Water and Wastewater Treatment Theory II or Advanced Water and Wastewater Systems, and ENVR 5530 - Natural System Behavior.

In Environmental Management, students may opt to specialize in solid waste or in water. Solid waste specialty courses include: ENVR 5310 - Groundwater Transport, ENVR 5610 - Solid Waste Collection, and ENVR 5400 - Environmental Systems Engineering. The water option calls for ENVR 4530 - Sanitary Engineering Laboratory, ENVR 5551 - Water Quality Management or 5301 - Stormwater Modelling I, and ENVR 5400 - Environmental Systems Management.

Students have the option of writing a thesis or not. Should one prefer to write a thesis, the student must present forty-five quarter hours of approved graduate courses. The major shall include a minimum of nine credits of thesis and eighteen of environmental engineering coursework. Those individuals who prefer to pursue the non-thesis option must present a minimum of forty-eight quarter hours of graduate courses. The major must include a minimum of twenty-seven quarter credits in environmental engineering coursework and a three hour special project.

The graduate program leading to the degree of Doctor of Philosophy is offered through the Department of Civil Engineering. Major fields of study include structural engineering, transportation engineering, and environmental engineering. For the Ph.D. degree, one must complete a minimum of one hundred and eight credits beyond the baccalaureate degree, inclusive of credit earned toward a master's thesis. Of this, a minimum of thirty-six credits are applied to doctoral research and dissertation. At least thirty-six credits must be taken in civil or environmental engineering. Approximately thirty-six credits must be in supporting, related scientific and engineering fields. These usually include such disciplines as mechanics, chemistry, mathematics, microbiology, physics, and other engineering fields. To insure scientific literacy, a student may be required to know/learn one foregin language if it is considered crucial to one's research efforts. After completion of half of the coursework, each student must pass a preliminary examination. After completion of the dissertation and prior to graduation, candidates must pass a final examination administered by a faculty committee.

CURRENT FACULTY, STUDENTS, GRADUATES

Seven persons have full-time responsibility to environmental engineering. Their efforts are divided to permit approximately two-thirds of their effort to go to teaching, and the remaining one-third is devoted to research.

There are thirty-two people enrolled in both master's programs full-time and twenty-one part-time. Nearly all of these students are receiving financial assistance in the form of teaching and research assistantships. Approximately sixty percent of the students are Tennessee residents. Four of the doctoral students are pursuing environmental engineering majors.

During the academic year 1976-1977, three Ph.D. degrees and sixteen master's degrees were awarded. A follow-up study of twenty-nine recent graduates show that twelve were employed in various government agencies, one is employed in a foreign government, three are pursuing Ph.D.'s, two are teaching, five are with consulting firms, ans six with private industry.

PROGRAM PROJECTIONS

Environmental engineering is a program in the midst of tremendous growth. It is hoped that in two years a mining option with an emphasis on reclamation will be approved. This program will lead to a Bachelor of Science in Civil Engineering. In 1980-1985 it is anticipated that a Bachelor of Science in Environmental Engineering will expand the engineering offerings. In the long range plans is a B.S. in county engineering.

Two new programs have been approved at the graduate level. A Master's in Civil Engineering in Construction Management and a joint degree program in Transportation/Urban Planning are in the immediate departmental planning stage.

COURSE DESCRIPTION (SELECTED)

ENVR 5150 Water and Urban Welfare - Evaluation of social, environmental and economic impact on planning and management of urban water systems. Procedures for analyzing multi-objective policy alternatives with selected case studies. (3 q.h.)

ENVR 5210 Advanced Water Resources Engineering - Complex problems encountered in water resources engineering. Analysis of problems preliminary to design of complex water resources structures. (3 q.h.)

ENVR 5232 Sediment Transportation - Sediment properties and their measurements; bed loads and suspended load movement; erosion, scour, transportation and deposition of sediments by flowing water; silting of reservoirs and related topics. (3 q.h.)

ENVR 5234 Flood Damage Reduction - Survey of national, regional, and local flood problems; hydrologic design criteria, traditional flood control measures; and other flood damage reduction elements; interdisciplinary approach in floodplain management. (3 q.h.)

ENVR 5263 Remote Sensing Data Analysis and Interpretation - Manual and automatic methods of data analysis and interpretation; use of automatic data processing equipment. (3 q.h.)

ENVR 5302 Stormwater Modeling II - Continuous streamflow records are interpreted using methods of stochastic hydrology. Hydrologic design of water resources systems using streamflow simulation techniques. (3 q.h.)

ENVR 5310 Groundwater Transport Processes - Dynamics of flow in porous media with emphasis on physical processes important in subsurface hydrology. Hydrodynamic dispersion, anisotrophy, layered soils, and unsaturated flow phenomena. Analytical solutions of flow equations. Dupuit approximation, analog and numerical methods, Hele-Shaw, and graphical solutions. (3 q.h.)

ENVR 5502 Water and Wastewater Treatment Theory II - Theory of physical, chemical, and biological processes employed in sanitary engineering. (3 q.h.)

ENVR 5513 Advanced Water and Waste Treatment Systems - Theory, operation, and use of advanced water and waste treatment systems. Emphasis on systems used for wastewater reclamation. (3 q.h.)

ENVR 5530 Environmental Engineering and Natural System Behavior - Relationship between environmental engineering and natural system behavior; focus on eutrophication and the limiting nutrient concept in relation to research and its translation into law and practice. (3 q.h.)

ENVR 5551 Water Quality Management - Water quality control objectives, methods, and philosophies; water quality criteria; regulatory standards; economic considerations. (3 q.h.)

ENVR 5561 Aquatic Environment Pollution - A study of effects resulting from agricultural, municipal, and industrial pollution upon physical, chemical, and biological characteristics of natural waters. (3 q.h.)

ENVR 5582 Microbiology for Sanitary Engineers - A study of microorganisms and microbiological processess which are significant in sanitary engineering, including basic microbiology, detection and identification, enzymes, metabolic reactions, energy transfer, synthesis and growth; aerobic and anaerobic biological treatment processes. (3 q.h.)

ENVR 5593 Advanced Sanitary Engineering Laboratory - Advanced laboratory techniques used in analysis of water and wastewater. Application of modern instrumental procedures for physical, chemical, and biological analysis. (3 q.h.)

ENVR 5600 Solid Wastes - Magnitude and characteristics of the solid waste problem; methods of collection and disposal, including sanitary landfill, incineration, composting, proposed new technologies, and recycling. (3 q.h.)

ENVR 5620 Solid Waste Collection Systems - Analysis and designs of collection systems, methods of collection, crew size, routing of vehicles, efficiency of collection systems, and management planning. (3 q.h.)

ENVR 5700 Planning and Air Pollution Control - Relationship between air pollution, area development, and urban growth. Social, economic, and political processes involved in air pollution control. (3 q.h.)

ENVR 5710 Air Pollution Control Engineering - Emission control systems for industrial and power generating processes, stack sampling methods, air monitoring, dispersion of pollutants. (3 q.h.)

ENVR 5725 Air Quality Modeling and Impact - Development of techniques to assess the air quality impact of major transportation projects and industrial air pollution sources. Application of atmospheric dispersion models and evaluation of meteorological and air quality data. (3 q.h.)

ENVR 5730 Air Pollution Control Device Design - Design and evaluation of systems used to control the emission of gaseous and particle air pollutants. Comprehensive design of specific devices and systems. (3 q.h.)

ENVR 5735 Industrial Source Sampling - Review and application of sampling methods for gaseous and particulate air pollutant emissions from industrial processes. (3 q.h.)

ENVR 5760 Diffusion in the Atmosphere - Movement and dilution of natural or man-made material released into the atmosphere. Basic theory is developed and observations reviewed. Specific topics include the rise of bouyant plumes, the relation between Eulerian and Lagrangian spectra, the differences between instantaneous and continuous sources, diffusion in a zone of wind shear and diffusion from urban area sources. (3 q.h.)

ENVR 6500 Industrial Waste Treatability and Process Control - Sources and characteristics of industrial wastes; treatment alternatives related to ultimate disposal, treatability and process control studies of physical, chemical, and biological processess using laboratory bench-scale treatment units. (6 q.h.)

INSTITUTION: UNIVERSITY OF TOLEDO

PROGRAM: Environmental Engineering, Engineering Science

DEPARTMENT: Chemical Engineering, Civil Engineering

DEGREE: Bachelor of Science in Chemical Engineering
Bachelor of Science in Civil Engineering
Master of Science in Chemical Engineering
Master of Science in Civil Engineering
Master of Science in Engineering Science

CONTACT:

Dr. Roger J. McNichols, Associate Dean
College of Engineering
University of Toledo
2801 W. Bancroft Street
Toledo, Ohio 43606
(419) 537-2405

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Toledo offers undergraduate and graduate degrees within its College of Engineering that recognize the need for professionals in environmentally related fields. Students may pursue baccalaureate degrees in Chemical Engineering with an emphasis in Environmental Engineering Pollution Control or in Civil Engineering with a technical elective concentration in Environmental Engineering. The former degree choice enables students to select technical electives "in air pollution, industrial waste treatment, biochemical engineering" and other areas. The latter option centers technical electives on "the design, construction and management of facilities for public water supply and sewage treatment" as well as "control of water and air pollution, water resources management and solid waste disposal."

According to the College of Engineering informational brochure, "The purpose of the master's degree programs is to provide opportunity for advanced study in the various areas of engineering of current importance. The programs feature sufficient flexibility that a student can either probe further into a particular area of specialization, broaden the educational experience into additional areas of that field of engineering, or synthesize an integrated program of interdepartmental studies." To actualize that purpose, graduate students at the master's degree level may choose from a number of program offerings including several with environmental orientations. In the Chemical Engineering department, graduate training is available in waste disposal and pollution control. Masters degree candidates in Civil Engineering may study environmental engineering systems of domestic and industrial water supply, and waste disposal and recirculation. An interdepartmental program within the College of Engineering--Engineering Science--typically emphasizes environmental pollution and its control.

Facilities at the University of Toledo are extensive. The school maintains well-equipped laboratories for teaching and research in biochemical engineering, biological wastewater treatment, analytical methods for examining water and wastewater, air pollution, environmental chemistry, and environmental biology. Library and computer facilities lend strength to the curriculum and research conducted in the College of Engineering. An Environmental Protection Agency Training Grant, in existence since 1965, provides the major support for the graduate training programs in air and water pollution control.

The Civil Engineering Department conducts periodic workshops for local industry (e.g., Owens Corning Fiberglas) on relevant environmental topics. Though not required, the Chemical Engineering Department places a sizable fraction (1/3-1/2) of its students in an industrial setting for their thesis research. These students receive partial support through university fellowships and sometimes additional support from the industry. The university provides research supervision through the student's major professor and the industry supplies the project, partial supervision, and out-of-pocket costs for the research.

PROGRAM REQUIREMENTS

Entrance to the baccalaureate degree programs in the College of Engineering requires a high school diploma or equivalent and a minimum of 12 units at the secondary level (4 in mathematics, 1 in chemistry, 4 in English, and 3 in humanistic-social electives). Physics, biology, and two years of a foreign language are recommended. Applicants for the master of science degree programs must hold an undergraduate degree in an appropriate field (e.g., Civil Engineering candidates must have a B.S. in Civil Engineering as prerequisite). The Engineering Science students must have a B.S. in Engineering, Chemistry, or Biology, and a minimum of two years of college calculus ending with differential equations.

The B.S. degrees require 200 quarter hours for graduation. There is a set of core courses common to all engineering degrees (25 mathematics hours, 25 basic science hours, 25 humanities and social sciences, 50 engineering science hours, 25 engineering design hours). Elective courses permit the student to "specialize along lines of personal and professional interest."

At the master's level, students must complete 45 quarter hours of coursework. A thesis project, up to 9 hours credit, is normally required but may be replaced with coursework in some programs or in the case of Civil Engineering and Engineering Science, with an informal research project. The master's degree in Engineering Science mandates completion of courses in unit operations of industrial waste treatment, advanced waste treatment, and bio-engineering.

CURRENT FACULTY, STUDENTS, GRADUATES

There are three full-time faculty in Chemical Engineering and three full-time faculty in Civil Engineering involved in these environmental programs. Student enrollment currently and the average number of graduates for the various degrees with emphasis in environmental areas are:

Degree	Student Enrollment Full-Time	Student Enrollment Part-Time	Average Number of Graduates
B.S. (Chemical Engineering)	1	0	NA
B.S. (Civil Engineering)	18	0	NA
M.S. (Chemical Engineering)	2	3	2
M.S. (Civil Engineering)	1	7	2
M.S. (Engineering Science)	2	11	2

A high percentage of these program graduates take jobs in industry with substantial percentages employed in government and consulting.

Undergraduates are eligible for some scholarships and the general financial aid programs available to all students. Almost all graduate students in the College of Engineering receive some financial support. Graduate assistantships provide student employment and experience in engineering education. The U.S. Environmental Protection Agency Training Grant supports three students a year, and there is some industrial support though variable. Most part-time students at night school are funded by their employers.

PROGRAM PROJECTIONS

The environmental programs at the University of Toledo anticipate faculty growth in numbers over the next few years. An individual with expertise in air pollution is needed if the program is to remain abreast of societal needs; and faculty in hydraulics, hydrology, and water resources are needed to relieve teaching loads in these areas--loads now being carried by Ph.D. candidates, team-teaching by existing faculty, or industrial personnel. Future program developments may bring about an industrial hygiene program, especially with the legislative impetus and demands of the Occupational Safety and Health Act and the Toxic Substances Control Act. A doctoral program in the environmental area is under consideration.

Faculty note the need to integrate air, water, and solid waste control training within environmental programs rather than focusing on them as completely separate areas of concern. Energy programs must also be considered.

COURSE DESCRIPTION

400 Level and below are Undergraduate Courses.
500 and 700 Level are Graduate Courses.

Chemical Engineering:

462 Introduction to Biochemical Engineering - Application of the principles of chemical engineering to biological processes involving living organisms. Microbial kinetics, fermentation pathways and batch and continued fermentation will be some of the topics covered. (3 q.h.)

463 Biochemical Engineering Processes - Study of the unit operations of biochemical engineering, pointed toward the design of systems involving living organisms, including the production of food, pharmaceuticals, and potable water. (3 q.h.)

465 Unit Operations of Industrial Waste Treatment - Industrial waste treatment is approached through a discussion of the fundamental principles underlying each significant treatment process or operation; following a study of the basics, empirical formulae are used to size and cost waste treatment plants. (3 q.h.)

466 Advanced Waste Treatment - The theme of the course is the use of waste water as a raw material for the production of industrial and/or potable water. The latest and most advanced processes for accomplishing this will be discussed including reverse osmosis, ion exchange, physical chemical treatment, tertiary filtration, activated carbon absorption, etc. (3 q.h.)

Civil Engineering:

361 Introduction to Water Supply - An introductory study of water supplies, including planning and development. Water treatment unit operations and their proper selection are studied. The basic analysis of water supply and distribution systems including a brief review of desired chemical and biological characteristics of water are studied. (3 q.h.)

362 Introduction to Waste Treatment - An introductory study of waste collection and treatment systems common to rural and metropolitan areas which utilize chemical and/or biological waste treatment processes. Waste characteristics and relationship to both treatability and stream compatibility are studied. Treatment unit operations will be reviewed in a manner so that proper selection dependent upon waste characteristics is learned. (3 q.h.)

461 Environmental Engineering Chemistry - A detailed study of the chemistry involved in the determination and progression of inorganic and organic materials which significantly contribute to water pollution. Emphasis is made to relate the engineering significance of each chemical species examined. (3 q.h.)

462 Environmental Engineering Chemistry Laboratory - Laboratory exercises utilizing standard procedures for inorganic and organic analysis of significant water pollutants. (3 q.h.)

463 Applied Hydraulics for Civil Engineers - The study of open channel flow, flow measurement, natural runoff and stream gaging. Aspects of ground water flow relative to well development and resultant unconfined drawdown, along with flow through porous media, are studied. Theory of sedimentation is examined. (3 q.h.)

464 Physical and Chemical Processes for Water and Wastewater Treatment - Physical and chemical processes for water and waste water renovation. Current theories of coagulation and partical aggregation, sedimentation filtration, adsorption, ion exchange, reverse osmosis and ultrafiltration, chemical oxidation, gas transfer and corrosion. (3 q.h.)

465 Theory of Biological Waste Treatment Processes - Aerobic and anaerobic biological processes for domestic and industrial waste water treatment. Current theories of estuary and river modeling, activated sludge processes, trickling filtration processes, oxidation ponds, nitrification and denitrification process. Anaerobic decomposition processes. (3 q.h.)

466 Aspects of Treatment Plant Design - Introduction to environmental and sanitary engineering design. Design of selected water and waste treatment plant operations utilizing knowledge gained from prerequisite coursework. (3 q.h.)

467 Environmental Engineering Microbiology - An introductory study of fundamental microbiology and biochemistry of microorganisms of importance to biological waste treatment operations. The application of these fundamentals to the design of biological waste treatment processes, the optimization of existing facilities and the basic understanding of natural purification processes will be examined. (3 q.h.)

468 Solid Wastes Engineering - A basic study of solid waste materials including origin, form, stability, environmental effects, methods of disposal and new techniques for reclamation and recycling. (3 q.h.)

469 Environmental Engineering Microbiology Laboratory - The identification of microbes and microbial properties which contribute to favorable and adverse effects upon (1) natural ecological systems and (2) biodegradation-waste treatment systems. (3 q.h.)

Engineering Science:

290 Energy and the Environment - The purpose of the course is to develop a greater awareness and understanding of the vital role

290 (Cont'd) - of energy in the total world society. Study of the uses on energy in the achievements of man, its limitations and potentialities as well as a survey of energy sources, conversion processes and cycles, and ultimate disposition. Environmental and economic implications of energy utilization in the modern world. (4 q.h.)

455 Nuclear Engineering I-An introduction to general problems in the field of nuclear engineering. Atomic structure, the decay of radioactive nuclei, nuclear reactions and radiation detection are considered in some detail. (3 q.h.)

456 Nuclear Engineering II - Health physics and biological radiation protection, radioisotope application neutron interactions, and the steady state reactor core are covered. (3 q.h.)

457 Nuclear Engineering III - Transient reactor behavior and control, radiation damage and reactor materials, nuclear heat transfer, and current nuclear reactors are studied. (3 q.h.)

461 Air and Water Pollution Control - Routes to solving environmental problems will be explored from the basic premise that environment control is no different from any other complicated processing problem and only requires the application of existing technology to achieve environmental control. In seeking control techniques, the interrelation between air, water and solid waste disposal will be emphasized. (4 q.h.)

465, 565/765 Air Pollution: Causes and Effects - The events leading to, sources of, and health effects associated with air contamination. Meterology, dispersion and concentration of pollutants from point sources. The automobile and its relation to air quality. (3 q.h.)

466, 566/766 Air Pollution: Control - A study of sampling and source analysis will define the magnitude of industrial sources of pollution. Control of particulates and gases. Control of sulphur and nitrogen oxides from stationary sources; automobile anti-pollution measures. Legal and regulatory aspects of air pollution control. (3 q.h.)

467, 567/767 Air Pollution: Instrumentation - A wide variety of instrumentation will be used to define and measure the extent of air pollution. High volume particulate sampling, SO monitoring, flow rate determination, efficiency checks on electrostatic precipitation, automobile exhaust analysis for unburned hydrocarbons, carbon monoxide, nitrogen oxides. (3 q.h.)

470, 570/770 Control of the Environment - An introductory study of basic scientific, technical and socio-political questions and issues pertaining to the interrelationship between man and the environment. Four to five trips to typical pollution control installations will be required. (4 q.h.)

Engineering/Chemical Engineering:

563/763 Biochemical Engineering Processes - An extension of the principles of biochemical engineering to the design of chemical plants employing biological catalysts. (3 q.h.)

565/765 Unit Operations of Industrial Waste Treatment - Theory and practice of industrial waste treatment preceded by discussion and investigation of basic principles of conventional sewage treatment. (3 q.h.)

566/766 Advanced Waste Treatment - The application of chemical engineering unit processes to the renovation of waste water. Topics include reverse osmosis, physical-chemical treatment, ion exchange and carbon adsorption. (3 q.h.)

667/867 Special Topics in Industrial Waste Disposal - Study and review of current topics from literature and practice of industrial waste disposal. (2 q.h.)

Engineering/Civil Engineering:

556/756 Urban Transportation Design - Travel characteristics; theory of urban travel and trip distribution models; Modal split; traffic assignment models; transportation planning and its relation to social, environmental and aesthetic considerations. Transport technology and the quality of urban life. (3 q.h.)

561/761 Environmental Engineering Chemistry - A detailed study of the chemistry involved in the determination and progression of inorganic and organic materials which significantly contribute to water pollution. Emphasis is to relate the engineering significance upon the environment of each chemical species examined. (3 q.h.)

562/762 Environmental Engineering Chemistry Laboratory - Laboratory exercises utilizing standard procedures for inorganic and organic analysis of significant water pollutants. Selected experiments relating to water and waste treatment. Selected reports pertaining to advanced analytical methods are made. (3 q.h.)

563/763 Applied Hydraulics for Civil Engineers - The study of open channel flow, flow measurement, natural runoff and stream gaging. Studies of friction factors in full flowing conduits are made. Aspects of ground water flow relative to well development and resultant unconfined drawdown, along with flow through porous media are studied. Factors affecting vortex development of various liquids and the theory of sedimentation are examined. (3 q.h.)

564/764 Physical and Chemical Processes for Water and Waste Water Treatment - Physical and chemical processes for water and waste water renovation. Current theories of coagulation and particle aggregations, sedimentation filtration, adsorption, ion exchange, reverse osmosis and utrafiltration, chemical oxidation, gas transfer and corrosion. (3 q.h.)

565/765 Theory of Biological Waste Treatment Processes - Aerobic and anaerobic biological processes for domestic and industrial waste water treatment. Current theories of estuary and river modeling, activated sludge processes, trickling filtration processes, oxidation ponds, nitrification and denitrification process. Anaerobic decomposition processes. (3 q.h.)

566/766 Aspects of Treatment Plant Design - Introduction to environmental and sanitary engineering design. Design of selected water and waste treatment plant operations utilizing knowledge gained from prerequisite course work. Sedimentation, filtration, biological and chemical treatment process operations are designed. (3 q.h.)

567/767 Environmental Engineering Microbiology - An introductory study of fundamental microbiology and biochemistry and microorganisms of importance to biological waste treatment operations and systems relating to water resources management. The application of these fundamentals to the design of biological waste treatment processes, the optimization of existing facilities, the planning of water purification processes will be examined. (3 q.h.)

568/768 Solid Waste Engineering - A basic study of solid waste materials including origin, form, stability, environmental effects, methods of handling, methods of disposal and new techniques for reclamation and recycling domestic and industrial waste materials. Theories for use in planning of waste collection systems are also developed. (3 q.h.)

569/769 Environmental Engineering Microbiology Laboratory - The identification of microbes and microbial properties which contribute to favorable and adverse effects upon (1) natural ecological systems, and (2) biodegradable waste treatment systems. (3 q.h.)

623/823 Ground Water and Seepage - Mechanics of flow of water thru soil. Control of ground water. Flow nets. Application of comformal mapping to ground water problems. (3 q.h.)

INSTITUTION: UNIVERSITY OF UTAH

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.), Master of Science (M.S.)
and Doctor of Philosophy (Ph.D.) in Civil Engineering

CONTACT: Dr. David W. Eckoff
Associate Professor, Engineering
University of Utah
Salt Lake City, Utah 84112
(801) 581-7200 x 6937

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Utah environmental engineering programs are administered through the Department of Civil Engineering. The program, at the baccalaureate level consists of an environmental option, but graduate students at all levels may pursue environmental engineering as an area of specialization.

In addition to the general civil engineering curriculum, the programs place strong emphasis on courses in air pollution, water and wastewater design, and solid waste management. These courses are especially well represented in the graduate level offerings.

Students and faculty utilize a multitude of teaching and research laboratories within the College of Engineering. These facilities, numbering over 30, are well equipped, up-to-date, and house a number of advanced research projects. Included in the main engineering building are the following laboratories, in partial listing: nuclear reactor; optical mechanics; supersonic wind tunnel; scanning electron microscope; transmission electron microscope; high altitude measurements; and, electron paramagnetic resonance.

The environmental engineering programs in the University of Utah Civil Engineering department, prepare graduates for occupations in environmental areas of solid waste, air, water, and wastewater. Technical elective courses in urban systems, transportation and planning prepare graduates of these programs for planning, management and administrative jobs as well as for the pollution control and abatement occupations.

PROGRAM REQUIREMENTS

Any postsecondary student who successfully gains admittance to the University of Utah may be admitted to the College of Engineering.

Academic background and test scores, however, indicate the level at which the student begins the course of study.

The baccalaureate students are encouraged to identify a major area of study as soon as possible. The first two years, however, may be completed within the College of Engineering's common first two-year schedule of courses.

In order to be eligible for the Bachelor of Science degree, the civil engineering student must complete at least 190 quarter hours, and be registered in the department for six consecutive quarters prior to registration.

The first two years of the baccalaureate program include strong emphasis on chemistry, physics and mathematics. The junior year usually includes: the completion of 33 1/2 quarter hours of civil engineering courses (numbered at the 300 level); and, 15 quarter hours of mechanical, industrial and electric engineering courses (at 300 level). The fourth year program includes the selection of a minimum of 19 quarter hours in technical electives. It is in this requirement that the environmental student may select: CE 554, 555, 556, 560, 562, 563, 565 or 566. The remaining 29.5 quarter hours include: 12 quarter credits liberal education; and 17.5 quarter hours civil engineering.

The Master of Science requirements include the following: 45 quarter credit hours including 9 quarter hours of thesis; a comprehensive examination; thesis defense.

The Doctor of Philosophy degree includes special requirements and courses of study as outlined by the departmental advisors.

Fellowships and assistantships are available to students. A partial listing follows: Phillips Petroleum Fellowship; University Research Fellowship; Water Pollution Fellowships; Steed Memorial Scholarship; and, John R. Call Scholarship.

CURRENT FACULTY, STUDENTS, GRADUATES

The current full-time faculty is composed of seven total members. The teaching component is made up of 4.5 cost-centered faculty and .5 full-time-equivalent from two departments to teach cross-listed courses (Biology and Geography departments). There are .5 cost-centered research personnel.

Currently the student enrollment includes 12 male and three female seniors for a total of 15 senior baccalaureate students. There are 10 full-time Master's level students: eight male and two female; two Ph.D. candidates bring the total number of graduate students to 12.

Per annum graduates have averaged approximately 10 at the baccalaureate level and five at the graduate level, over the last three years. These are included in the average per annum number of civil engineering graduates which numbers approximately 35.

Although the graduates of these programs encounter few, if any, obstacles to employment, approximately 80% of the baccalaureate students enter graduate programs. Approximately one-half of these will attend Stanford, MIT, Utah State University and UC Davis. The other one-half remain at the University of Utah.

PROGRAM PROJECTIONS

There are no faculty increases or decreases anticipated over the next few years. One staff replacement will be sought in 1978-79.

The program enrollment is considered to be stable at present. No significant growth is anticipated.

There is some discussion, at present, regarding a very slight shift in program emphasis. This shift would include an added accent on urban systems in conjunction with environmental engineering. This would, overall, offer a program in environmental systems. No time-lines have been established regarding this change.

COURSE DESCRIPTION

Undergraduate courses:

CE 131 Dynamics - Kinematics of particles and rigid bodies in fixed and moving coordinate systems; kinetics of particles and rigid bodies; work, kinetic, and potential energy; impulse, linear and angular mementus; Euler's equations; gyroscopic motion and elementary vibration theory. (Jointly listed as ME 131) (3 q.h.)

CE 20 Urban Systems - Zoning, street systems, and municipal facilities. (3 q.h.)

CE 341 Soil Mechanics I - Structure, texture, sampling, classification density, consistency, stress, distribution, strength, consolidation, capilarity, permeability of soils. (4 q.h.)

CE 352 Hydrology - Surface and groundwater hydrology, flood and drought analysis, reservoir operational studies. (3 q.h.)

CE 360 Water Treatment and Waste Disposal - For Non-Civil Engineers. Methods of water treatment, routine laboratory testing, protection of systems, domestic waste disposal by water carriage and non-water carriage methods, small unit and municipal disposal methods. (3 q.h.)

CE 363 Water Supply and Sewerage - Principles of design, construction and operation of water and wastewater systems and treatment works. (4 q.h.)

CE 370 Transportation Engineering - Introduction to basic planning, design, and operational principles of various modes of transportation for urban and regional applications. (3 q.h.)

Graduate courses (and upper division):

CE 517 Matrix Methods of Structural Analysis - Application of matrix methods in bridge analysis and continuous structures. (3 q.h.)

CE 520 Regional Systems - Principles of planning on a regional basis, integration of urban areas, recreational facilities, transportation systems, industrial sites, etc. (4 q.h.)

CE 525 Elements of City Planning - An investigation of methods, techniques, and procedures, which characterize city planning as it has emerged up to the present time, encompassing an understanding of the physical environment as well as the recognition of the economic, social, and political forces of society. (Jointly listed as Geography 525) (3 q.h.)

CE 527 Principles of Regional Planning - A survey of the theory and problems of regional development, including principles of the location of economic activity, theories of regional growth, and public policy for development of regions. (Jointly listed as Geography 527) (3 q.h.)

CE 530 Vibrations - Free and forced vibrations of discrete linear systems with and without damping: Lagrange's equations and matrix methods for multiple degree of freedom systems, isolation of shock and vibration. Applications including vibrations in machines and structures. (Jointly listed as ME 530)(4 q.h.)

CE 554 Water Resource Engineering - Elements of water resources engineering, river engineering, hydraulic structures, economic and environmental effects of water resources developments. (4 q.h.)

CE 556 Environmental Fluid Mechanics - Principles of transport and mixing processes in air and water. Effects of advection, density currents, turbulence and Fickian diffusion on pollution in streams, lakes, estuaries, seas and the atmosphere. Outfall and intake planning considerations. (4 q.h.)

CE 557 Hydraulic Systems - Overall effects of hydraulic systems and structures, considerations in hydraulic design. (4 q.h.)

CE 560 Solid Waste Management - Quantities and composition of various classes of solid waste; storage and collection; design and operation of collection systems; records, finance, personnel and systems management. (4 q.h.)

CE 561 Air Pollution Ecology - Identification and evaluation of the sources, fate, and effects of air pollution in the environment. (Jointly listed as Biology 578) (4 q.h.)

CE 562 Environmental Sanitation - Dry refuse disposal, insect and rodent control, air pollution, control, housing, institutional sanitation, food handling, industrial hygiene and other environmental health problems. (4 q.h.)

CE 563 Air Pollution Control Techniques - Air pollution emission sources, behavior of pollutants in the atmosphere, theory and practice of control of particulate and gaseous air pollutants at their sources. (Jointly listed as Ch.E. 563) (4 q.h.)

CE 564 Environmental Engineering Chemistry - Sampling methods and principles and practice of physical, chemical and biological analyses of water, wastewater and solid wastes. (3 q.h.)

CE 565 Design of Water and Wastewater Systems - Design of water distribution systems and treatment works, design of wastewater collection systems and treatment works, stream pollution control. (4 q.h.)

CE 566 Environmental Quality Management - Application of scientific, engineering and management technologies in the solution of both small and comprehensive environmental quality problems. (4 q.h.)

CE 620 Advanced Urban Systems - The theory and practice of urban systems engineering. (3 q.h.)

CE 656 Advanced Hydrology - Consumptive use, water quality, statistical methods, maximum possible storms, design floods. (3 q.h.)

CE 659 Ground Water Hydrology - Classification of rocks and their water bearing properties, elementary theory of ground water movement, mechanics of well flows, well practices. (3 q.h.)

CE 678 Intercity Transportation Planning - Analysis and planning of multimodal rural and intercity transportation systems on statewide, national, and international scales. Emphasis is placed on such areas as planning, methodology, needs studies, travel demand estimation, freight movements, socio-economic an political impacts. (3 q.h.)

CE 661 Urban Water Supply Systems - A water supply requirements, supply sources, kinetics and process design, quality control and distribution for municipal and industrial waters. (4 q.h.)

CE 662 Urban Wastewater Systems - Wastewater collection system design, treatment criteria, kinetics and process design, advanced waste treatment and water reclamation for municipal and industrial wastewaters, receiving water quality requirements and disposal practices. (4 q.h.)

CE 666 Advanced Waste Treatment - Applications and design of facilities for advanced waste treatment of municipal and industrial wastes. Processes include soil systems, particulate removal, chemical precipitation, physical adsorption, demineralization through membrane processes and ion exchange, and biostimulant removal. (4 q.h.)

CE 667 Sanitary Engineering Unit Operations - Design and analysis of bench-scale and pilot plant systems for study of water and wastewater treatment processes and solid waste processing and disposal. (4 q.h.)

CE 676 Urban Transportation Planning - Urban transportation problems; theories and process of transportation planning; definition of goals and objectives, modal demand analysis, supply systems characteristics; formulation of transportation plan; evaluation principles and criteria; implementation; case planning studies. (3 q.h.)

CE 744 Advanced Vibrations and Wave Propagation - Vibrations of strings, rods- membranes, beams, shafts and plates; traveling and standing waves; reflection, diffraction and distortion of waves; surface waves; nonlinear oscillation. (3 q.h.)

INSTITUTION: UNIVERSITY OF WISCONSIN - MADISON (UWM)

PROGRAM: Civil and Environmental Engineering

DEPARTMENT: Civil and Environmental Engineering (C.E.E.)

DEGREE: Bachelor of Science (B.S.)

CONTACT: Dr. William Edward Saul
1415 West Johnson
2205 Engineering Building
Madison, Wisconsin 53706
(608) 262-3542

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil and Environmental Engineering (CEE) offers a curriculum that provides a balanced program of technical and non-technical courses to meet the needs of students interested in studying civil and environmental engineering. Many special programs are offered at both the undergraduate and graduate levels. These include water resources engineering, ocean engineering, remote sensing, city planning, solid wastes disposal and water chemistry. The discussion here is limited to the B.S. degree in Civil and Environmental Engineering.

PROGRAM REQUIREMENTS

It is recommended that the 16 units needed for admissions include four years each of mathematics and English, and one year each of chemistry and physics. Entering freshmen are placed in mathematics courses on the basis of both their high school mathematics preparation and scores on required placement tests.

The Freshman Professional Orientation course helps students develop an understanding of the varied facets of the engineering profession and achieve maximum benefit from their freshman year in engineering. Speakers include outstanding faculty members from the College of Engineering and from other colleges of the University, as well as noted people in industry. All engineering freshmen are required to enroll in Engineering Freshman Professional Orientation, or an appropriate substitute, during the first semester in which it is offered during their residence.

A B.S. degree requires 135 semester hours. This includes 74 credits of electives in the fields of natural science, liberal studies, civil and environmental engineering methods, designated electives from hydraulics, sanitary engineering, structures and geotechnical engineering, surveying-photogrammetry and remote sensing or transportation and city planning, technical, and free. The remaining 61 required credits are taken in various engineering departments including CEE and the mathematical areas. This program flexibility practically insures that no two students who graduate from the College of Engineering have necessarily taken identical programs.

CURRENT FACULTY, STUDENTS, GRADUATES

Some sources of research funding have been Sea Grant Program, National Science Foundation, National Aeronautics and Space Administration, UWM Water Resources Center, Institute for Environmental Studies, U.S. Environmental Protection Agency, City of Madison, Wisconsin Department of Natural Resources.

Laboratory facilities include fluid mechanics, hydraulics, field study, sanitary, and water chemistry. A new Water Resources laboratory is presently under construction and will concentrate most of the water-related research from all departments on the campus in one building. The Madison Metropolitan Sewerage District (MMSD) has cooperated with UWM in establishing the sanitary engineering field laboratory and pilot plants at their Nine Springs Sewage Treatment Plant.

Fifteen percent (80) of the 526 civil and environmental engineering students are female. There are over 100 graduates per year. The largest influx of transfer students does not come from other than four-year institutions.

Financial aids include scholarships, grants, loans, and employment programs. Full-time faculty numbers 28, part-time 2.

The Engineering Placement Office offers many services to students and graduates. One is a Pre-Selection Program making it possible for each student to register with the Placement Office during the spring prior to the year of graduation. By doing so the student's interview form is printed in quantity and is made available to employers in advance of campus recruiting visits.

The cooperative programs offered through the College of Engineering allow undergraduates to alternate periods of college attendance with periods of practical work experience.

Opportunities also exist for students to study engineering in Mexico, France or Germany. A "B" average and college level knowledge of the native language are required for this international study opportunity.

PROGRAM PROJECTIONS

The department sees a change in long-range goals and objectives of the program when funding on a national level changes.

ADDITIONAL INFORMATION

Numerous workshops are held in cooperation with the College of Engineering - Madison and University of Wisconsin - Extension. Extension is one of approximately 30 institutions in the University of Wisconsin System and Engineering sponsors many workshops, seminars, institutions, etc.

The Institute for Environmental Studies (IES) University of Wisconsin - Madison, which was founded in 1970, is a campus-wide organization to develop interdisciplinary programs pertaining to man and his environment. It combines an environmental curriculum with a comprehensive research program for graduate and undergraduate students. The teaching staff of over 50 professors and lecturers has ties with 23 departments besides environmental studies.

COURSE DESCRIPTION

Undergraduate/Graduate courses (a partial listing):

320 Sanitary Engineering - Fundamental sanitary aspects of environmental engineering; topics: Role of the engineer in the control of the environment; water supply and wastewater problems, solid waste disposal; air pollution; and administration in environmental engineering. (3 s.h.)

321 Environmental Pollution Control for Non-Engineers - Water, land, and air pollution control technology to show the engineering approach to pollution problems, to outline solutions based on current technology, and to consider technical and economic constraints on solutions. (3 s.h.)

325 Design of Water Distribution and Wastewater Collection Systems - Application of basic principles in sanitary engineering and hydraulics to the design of conduits, water distribution systems; reservoirs, pumping stations, and storm water and sanitary sewage systems and appurtenances. (3 s.h.)

326 Design of Water and Wastewater Treatment Plants - Unit operations in water and wastewater treatment; sedimentation, chemical coagulation, ion exchange, filtration, disinfection; design of a water treatment plant; the natural or self-purification of water; physical, chemical and biological processes for treatment of wastewater; sludge treatment and disposal; design of a sewage treatment plant. (3 s.h.)

327 Solid Wastes Engineering - Basic concepts in designing, evaluating, and operating solid wastes storage, collection, and disposal systems; land and incineration disposal methods; air pollution as related to solid wastes legal, political and administrative considerations. (3 s.h.)

370 Transportation Engineering - Characteristics of transportation supply and demand; measuring and estimating demand; social and environmental impacts; planning of transportation systems; characteristics of transportation modes; interaction between modes; mode interfaces; transportation technology; economics; public policy, implementation and management. (3 s.h.)

415 Water Resources Engineering - Application of principles of hydraulics, hydrology and water control to problems in erosion control, flood control, water power, irrigation, navigation, and river basin planning; includes design principles of water relating structures. (3 s.h.)

416 Optimization and Simulation of Water Resources Systems - Basic concepts of systems analysis applied to water resources. Introduction to optimization and simulation methodology. Development and application of water quality models and water resources management techniques. Use of stochastic and parametic hydrologic models. (3 s.h.)

421 Water Supply and Pollution Control - Elements of water supply and wastewater treatment processes, and pollution control. (2 s.h.)

423 Air Pollution--Effects, Measurement, and Control - The influence of man-caused pollution on the atmosphere, globally and locally. Evaluation of human health, economic, and aesthetic effects of air pollution. Techniques for measurement of atmosphere pollutant concentrations and determination of local and regional air quality. Detailed presentation of air pollution sources and methods for their control. The role of local, state and federal government in air pollution control. (3 s.h.)

424 Water Analysis - Lab methods and the interpretation of lab results for chemcial and biological analyses of water and wastewater. (3 s.h.)

516 Ocean Environment - Introduction to sea and fresh water environments. Course is four sections: biological oceanography, chemical oceanography, geological and geophysical oceanography, and physical oceanography. Each independent of the others, and taught separately. Student can take any number of sections. (1-4 s.h.)

521 Industrial Waste Treatment - Characteristics and composition of industrial wastes, sampling and methods of anlaysis of industrial wastes, and remedial measures for treatment, in-plant conservation, material, reclamation, recycling and disposal. (2 s.h.)

525 Radioactive Waste Treatment - Methods and unit processes used for the treatment of radioactive wastes; effects of usual water and sewage treatment processes on the removal of radioactive nuclides, and ultimate disposal of radioactive wastes. (3 s.h.)

552 Remote Sensing of the Environment - Principles, characteristics and applications of remote sensing of the environment. Emphasis on airborne remote sensing of the earth's environment. (3 s.h.)

556 Romote Sensing Image Interpretation - Techniques of enhancement and quantification of remote sensing imagery. Emphasis on processing and analyzing data gathered by airborne and satellite sensors. Techniques to quantitatively analyze data from photography, electro-optical scanners, satellite systems, and radar and passive microwave systems. A five-week practicum with applications to: agriculture and forestry, geology and soils, water quality, and urban and regional planning. (3 s.h.)

570 Environmental Impacts of Transportation Systems - Intermediate level. Nature of the ecosystem and ecosystem modelling, the nature of transportation produced impacts on man's social, economic, physical and emotional well being, on wildlife, natural areas, agricultural areas; environmental economics; measuring and evaluating environmental quality, and citizen tactics in response to environmental issues. (3 s.h.)

572 Airports - The nature of air travel and aircraft technology; environmental impacts; airport operations and flight control; airport planning and design; site selection, configurations, design details; new airport concepts; terminals, support functions; airport access; heliport design and operation. (2 s.h.)

580 Water Chemistry - Chemistry of the elements in fresh and marine water; acidic and basic, precipitation, complexation, oxidation-reduction, sorption, and biochemical reactions in natural waters and water treatment processes. (3 s.h.)

621 Solid Waste Engineering II - Detailed engineering and management considerations related to the design and operation of solid wastes collection and disposal systems; solid wastes survey; systems approach to design; design of land disposal operations; incinerator evaluations and design; composting; salvage systems; special wastes; new methods of collection and disposal; administrative considerations. (3 s.h.)

624 Cost Engineering for Water Pollution Control - Use of forecasting, cost estimating and analysis, and optimization methods for the design of sanitary engineering systems, with major emphasis on water and waste-water treatment. (2-3 s.h.)

INSTITUTION: UNIVERSITY OF WISCONSIN-MADISON

PROGRAM: Water Resources Management, Environmental Monitoring, Land Resources

DEPARTMENT: Institute for Environmental Studies

DEGREE: Master of Science in Water Resources Management (M.S.)
Master of Science and Doctorate in Environmental Monitoring (M.S.) (Ph.D)
Master of Science and Doctorate in Land Resources (M.S.) (Ph.D.)

CONTACT: Dr. Reid A. Bryson, Director/Dr. Arthur B. Sacks

Institute for Environmental Studies
1339 Meterology & Space Science Building
1225 West Dayton Street

Coordinator of Academic Program
Institute for Environmental Studies
70 Science Hall
550 North Park Street

University of Wisconsin-Madison
Madison, Wisconsin 53706

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Institute for Environmental Studies offers interdisciplinary education for undergraduate and graduate students. Undergraduates in the College of Letters and Science are currently developing environmental studies majors in consultation with the Institute of Environmental Studies (IES) through the Individual Major Program. A formal undergraduate major in environmental studies is before the College of Letters and Science for its review. Degrees in Environmental Studies, per se, are not available at the University of Wisconsin-Madison at this time. However, students may get involved in this area through 1) association with IES, 2) a number of cross-departmental programs, and 3) a wide variety of departments currently emphasizing environmental studies.

IES administers three graduate programs: an M.S. in Water Resources Management, and M.S. and Ph.D. degrees with majors in Land Resources and Environmental Monitoring. Possibilities for a graduate program in Environmental Systems Analysis are currently being explored with the Graduate School and the University Administration.

PROGRAM REQUIREMENTS

An individual with an undergraduate or graduate degree in the biological sciences, earth sciences, economics, engineering, law, urban and regional planning, landscape architecture, mathematics, journalism, political science, or other suitable fields may apply for admission to the Water Resources Management Program. The general admission requirements of the Graduate School apply. Two options are available. Most students elect the 45-credit option; however, individuals with three or more years of professional experience and/or those with advanced degrees may elect the 30-credit option.

Double masters programs can be arranged with the consent of appropriate departments. Basic requirements for the 45-credit hour option include a minimum of 30 credits in the core curriculum plus a minimum of 15 credits within an area specialty. This option generally requires four semesters and one summer session. In the second option, a minimum of 30 credits in the core curriculum is required. The choice of courses should supplement relevant experience. This option generally requires two semesters and one summer session.

Students should enter the interdisciplinary Environmental Monitoring program with depth in a discipline. Normally this discipline will be in one of the natural science or engineering fields such as botany, chemistry, civil and environmental engineering, computer science, electrical engineering, forestry, geography, geology and geophysics, meteorology, physics, soil science, or zoology. Physical planning and/or design fields such as landscape architecture or urban and regional planning are also appropriate disciplines. Applicants presenting other backgrounds may be considered for admission with deficiencies. As part of their applications, students must submit a statement indicating the nature of their particular interdisciplinary program interests and three letters of recommendation. All applicants must meet the general requirements of the Graduate School.

A minimum of 30 credits of graduate study is required for the M.S. degree. Of these 30, students must meet Depth, Breadth, Interdisciplinary Synthesis, Thesis, and other requirements. Similar requirements apply for the Ph.D. degree. At the present time, the Environmental Monitoring Program stresses the application of remote sensing techniques to environmental problem-solving.

The Land Resources Program is most appropriate for individuals with undergraduate training or experience in resource planning or management; natural or earth sciences; engineering or design; land institutions; or the economics, history or geography of land. Applicants with backgrounds in areas other than these, but with a strong interest in land resource problems, may enter the program with special permission. The general regulations of the Graduate School apply to all admission. In addition, persons applying to this degree must submit a statement indicating the nature of their specific program interests as well as three letters of recommendation.

The M.S. requires a minimum of 30 credits; the Ph.D. requires a minimum of 64 credits. The degree format is structured to foster both depth and breadth in knowledge related to land resource problems. A student may draw freely from the course offerings of several departments, but an individual's program as a whole must be directed toward specific goals with the student's research related to the same goals as his/her course work selections. Candidates for the M.S. degree must complete a thesis or a supervised research paper in lieu of a thesis. Ph.D. candidates are required to submit a research thesis.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of 52 faculty comprise the Institute staff. Most are departmentally based and contribute only part-time to the Institute; however, five faculty members have their primary homes within the Institute, which has the ability to tenure faculty. Whenever possible, faculty appointments are joint with disciplinary departments.

There are 72 students in the Water Resources Management M.S. program; seven M.S. and seven Ph.D. candidates in the Environmental Monitoring program; and 21 M.S. and 14 Ph.D. students in the Land Resources program.

Graduates of the Water Resources program have had no difficulty finding employment (approximately 20 are graduated each year). All are employed in their field; 50 percent in the private sector, 50 percent in government. The Land Resources program was begun in 1976, and the Environmental Monitoring program in 1977.

PROGRAM PROJECTIONS

The IES offerings may be expanded to include environmental health, environmental planning, environmental systems analysis, and energy.

ADDITIONAL INFORMATION

The Institute offers three-week intersession courses for undergraduates. Workshops and seminars in water quality and mining and oil shale development have been presented.

COURSE DESCRIPTION (A partial listing)

101 Forum on the Environment - Lectures, discussions, and field study of environmental problems. Philosophical, political, and social implications are discussed, as well as technical considerations. (3 s.h.)

121 Atmospheric Environment of Man - The interactions of man and his societies with the atmospheric environment. (2 s.h.)

122 Climatic Environments of the Past - Climatic history of the last 10,000 years; the environmental background of history. (2 s.h.)

127 Physical Systems of the Environment - Climatic regimes, land forms, soils, water and life forms at the earth's surface in terms of energy-transforming processes, locational patterns, and changes through time. (5 s.h.)

300 Environmental Management - An integrated, interdisciplinary survey course to give basic understanding of current issues calling for intelligent citizen action. Resource management science, technology, history, organization, and philosophy. (3 s.h.)

321 Environmental Pollution Control for Non-Engineers - An introduction to air, land, and water pollution control technology. Intended to convey the engineering approach to pollution control technology. Intended to convey the engineering approach to pollution problems, solutions, and to define the technological and sociological interface in arriving at these solution. (3 s.h.)

323 Environmental Microbiology - Relationships of microorganisms to their environment and to other organism. The course will cover soil, aquatic, and geomicrobiology, and microbial symbioses. (3 s.h.)

324 Soils and Environmental Pollution - Interaction of soils with environmental contaminants and the role of soils in pollution control. (3 s.h.)

336 Our Hazardous Environment - An analysis of the unexpected: Hazardous elements of our physical environment (such as hurricanes, tornadoes, floods, earthquakes, etc.)--their physical characteristics, regional distribution, economic aspects, and human adjustments. (3 s.h.)

371 Nuclear Energy and the Environment - Fission and fusion processes, nuclear reactors, power plants, radioactivity, biological effects, radiation and thermal releases, governmental regulations' impact on society. (3 s.h.)

400 Environmental Core Studies - Lecture, discussion and field trips for intensive, interdisciplinary study of environmental topics. Technical, political, economic, social, and philosophical implication are included. Past topics include: Alternative Sources of Energy, Predicting Food Supplies, Energy Conservation, Issues in Human Population Control, Environmental Law and Decisionmaking and Environmental Systems Analysis. (2-4 s.h.)

440 Environmental Decisionmaking - The course will examine the environmental decision process within a broad cultural and historical perspective. Emphasis will be upon the sociopolitico-economic forces that influence decision-making. (3 s.h.)

441 Environmental Ethics - Treatment of ethical theories with an eye to their adequacy or inadequacy in handling such wrongs as harm to the land, to posterity, to endangered species, and to the ecosystem itself; exploration of the view that not all moral wrongs are based directly or even indirectly upon harm to human beings; critical treatment of possible grounds for that view; inquiry into the notion of the quality of life and the ethics of what have been termed "overcrowded lifeboat situations." (3 s.h.)

506 Modeling and Analysis of Environmental Systems - An upper-level course in systems modeling intended for students in the physical sciences who are interested in applications to environmental problems, and for students in life sciences who are interested in system methods. (3 s.h.)

516 Ocean Environment - A survey of sea and fresh water environments (other than water motion); includes applied marine biology, water chemistry, and geological oceanography. (1-3 s.h.)

535 Atmospheric Dispersion and Air Pollution - The physical principles of transport processes in the atmosphere, and how the processes vary with time and place, resulting in high levels of local and regional pollutant concentration. The environmental implications of air pollution and control strategies for preservation of atmospheric quality. (3 s.h.)

552 Remote Sensing of the Environment - Emphasis on airborne sensing. Characteristics and uses of photography, electro-optical scanners, multispectral imagery, radar imagery, passive microwave sensing, and other sensors. Applications to air and water quality studies, geography and geology, highway and traffic engineering, soils mapping and evaluation, urban and regional planning, and other fields. (3 s.h.)

666 Environmental Monitoring System Study - Interdisciplinary approach to formulation and solution of major environmental problems; problem definition including related issues; alternative solutions and detailed design. (3 s.h.)

719 Water Resources Management Practicum - An interdisciplinary team of students and staff work closely with agency personnel, citizen groups, and/or private sector representatives on the analysis of a contemporary, problem-oriented water resource issue. Physical, biological, economic and social aspects of the issue are integrated into the analysis through the use of small teams and group discussion. Course involves extensive interviewing and literature review. (6 s.h.)

761 Colloquium in Air Pollution - Discussion of current research at the University on emission sources, engineering control of air pollutants, atmospheric modeling, health and plant effects. (1 s.h.)

765 Environmental Monitoring Practicum I - An interdisciplinary workshop that will investigate "real world" environmental problems. Environmental monitoring will be one of the sources of data required for investigation. The topic will be chosen each year by the faculty and students in the Environmental Monitoring Degree Program. The course is intended to be an example of interdisciplinary synthesis and analysis. A comprehensive report will be prepared by the students enrolled. (3 s.h.)

920 Environmental Monitoring and Data Acquisition Seminar - Selected topics dealing with environmental monitoring and data acquisition, with emphasis on remote sensing of the environment. (1 s.h.)

935 Seminar in Air Resources Management - An interdisciplinary investigation seminar focused on a specific current problem in air resource management with staff and students contributing to the development of the issues, methodology, data, analysis, and policy formulation. (2 s.h.)

966 Seminar in Water Resources Planning - Governmental and legal aspects of water resources management; problems of public policy for control and use of water and related land resources. (2-3 s.h.)

INSTITUTION: VANDERBILT UNIVERSITY

PROGRAM: Environmental and Water Resources Engineering/
Environmental Science

DEPARTMENT: Environmental Engineering and Policy Management

DEGREE: Master of Science (M.S.)
Master of Engineering (M. Eng.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Karl B. Schnelle, Jr., Chairman
Department of Environmental Engineering and Policy Management
Vanderbilt University
Nashville, Tennessee 37240
(615) 322-4757

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering began at Vanderbilt as a program in 1962. Five years later Sanitary and Water and Wastewater Resource Engineering became a department. After six major departmental changes, the name became Environmental Engineering and Policy Management.

The primary focus of advanced level studies in this department is on the development of modern quantitative techniques and their application to practical problems encountered in the field of environmental pollution and control. Advanced analytical, numerical, and statistical methods are combined with elements of water quality, systems analysis, hydraulics, biology, and chemistry to provide the necessary background for conducting significant design, planning, and research in the environmental area.

Current research projects include studies on thermal pollution, waste assimilation, stratified flow dynamics, industrial waste treatment, biological waste treatment, effects of pollutants on water quality in reservoirs, and methods of environmental education of the public. Students are all required to use computers in course work and are encouraged to use computer analysis in their research projects. Research needs of the program are served by the Joint University Libraries System which holds more than 1.25 million volumes and a catalogue of approximately 6,400 periodicals. Complete facilities are available for water analysis, including atomic adsorption, spectrophotometry, and gamma-ray spectrometry. Extensive facilities for water and water treatment pilot plants and hydraulic research (including a 60 foot flume) are available. The air pollution laboratory houses a full range of sampling, flow measuring, and analytical equipment, including several automatic recording type instruments. In addition, a partial analytical equipment inventory includes a gas chromatograph, ultraviolet and infra-red spectrophotometers, zeta meter and a recording polaragraph.

PROGRAM REQUIREMENTS

A bachelor's degree in engineering or science, completed with a 3.0 (on a 4.0 scale) grade average is required for admission to the Department of Environmental Engineering and Policy Management. Competence in given areas is a key factor in admission decisions, not necessarily how many courses one may have taken.

The normal requirements for an M.S. degree include the completion, with a B average, of at least twenty-four semester hours of formal course work and the submission of a thesis. Students have the option in this program of following a non-thesis plan which requires thirty semester hours of graduate study, presentation of an oral report to a research seminar on a subject in the field of investigation, and submission of a written account of this work to the supervisory professor.

An advanced professional degree which is especially designed for engineering practicioners who prefer to continue working while engaged in graduate study is available. Students may complete one course at a time and they have seven years to finish the Master of Engineering degree. Thirty semester hours, including twelve hours in the candidate's chosen program, are required. The remaining hours may be approved courses in other programs. At least twelve hours must be chosen from courses designated as Engineering Graduate Professional Courses.

Five options for specialization exist. They are: Water and Wastewater Treatment Engineering, Water Resources, Air Resources, Solid Waste, and Environmental Science. A core curriculum for each has been developed to guide the students through their respective programs. Should the curricula not be pursuant to the needs of a student, then together with his/her advisor, a request for variance may be filed with the director of the program. This request should be made early in the course of a student's study.

A program in Environmental Science requires students to take the following courses: EWRE 222 - Methods of Scientific Research, EWRE 250 - Principles of Water Treatment and Waste Water Disposal or EWRE 280 - Atmospheric Pollution or EWRE 295 - Solid Waste Management, EWRE 270 - Public Health Engineering, EWRE 271 - Environmental Chemistry, EWRE 272 - Microbiology of Water, Wastewater, and Air, EWRE 273 - Environmental Chemistry Laboratory, and finally, MATH 252 - Statistical Analysis for Environmental Scientists and Engineers.

Individuals wishing to pursue the Doctor of Philosophy degree design programs of study, in consultation with their advisors, which are specific to their educational objectives. The doctoral program normally takes two and one-half to three years of work beyond the M.S. degree level. The first two years are generally devoted to coursework and to preparation for the general examination which admits one to doctoral candidacy. Most students require one year to complete the dissertation, work on which ensues after the second year. The final public oral examination is held after the dissertation is submitted, and consists of a thesis defense and an examination of the student's expertise in his/her field of study.

CURRENT FACULTY, STUDENTS, GRADUATES

Including the department chairman, there is the equivalent of nine full-time faculty whose primary focus is on teaching. During 1977, there were six persons enrolled in the Master of Engineering program, sixteen in the Master of Science program, and ten seeking a Ph.D. degree.

Approximately 50 percent of the graduate students are receiving financial assistance. Such aid is available to all M.S. and Ph.D. candidates in amounts up to $4,000 per year plus tuition. The EWRE program has a variety of fellowships and assistantships available. Students who are receiving support from fellowships or traineeships or by research or teaching assistantships may take normal course loads.

While precise figures are not available, it is estimated that 40 percent of the graduates from the past three years have been employed by EPA, 25 percent have been employed by state agencies, 10 percent by other federal agencies, and 25 percent have gone to private consulting firms and industry.

PROGRAM PROJECTIONS

Since its inception, this department has undergone six major upheavals. The result of that constant flux is that officials are now striving to achieve departmental stability.

There is currently a moderate recruitment effort being made. Officials would like to see the master's enrollment level reach forty.

COURSE DESCRIPTION

MATH 252 Statistical Analysis for Environmental Scientists and Engineers - Frequency distributions, central tendency, dispersion, classical distributions, comparison of means and variances, correlation, linear and nonlinear regression. Applications to environmental studies. (3s.h.)

EWRE 222 Methods of Scientific Research - Scientific investigations as illustrated by study of case histories. Preparation for research, hypotheses in science, planning experimentation, the role of chance in scientific discovery, intuition in science; difficulties in research, style and taste in research, strategy in research, scientific knowledge, and social values. (2 s.h.)

EWRE 270 Public Health Engineering - Principles of public health engineering, study of vector control, communicable disease control, milk and food sanitation, refuse disposal, and general environment sanitation. (2 s.h.)

EWRE 271 Environmental Chemistry - Theoretical aspects of physical, organic, and inorganic chemistry as applied to environmental engineering problems. (3 s.h.)

EWRE 272 Microbiology of Water, Waste Water, and Air - Principles of biology and their application to environmental science with emphasis on microbiology of air, water, sewage, and industrial wastes. (4 s.h.)

EWRE 273 Environmental Chemistry Laboratory - Chemical analysis of water and waste water and the laboratory control of water purification and waste treatment processes. (3 s.h.)

EWRE 277 Open Channel Hydraulics - Resistance in open channels. Hydraulic design of channels. Steady, non-uniform flow (backwater curves). Unsteady, non-uniform flows. Method of characteristics. Numerical solutions for unsteady flows. (3 s.h.)

EWRE 278 Hydrology - Hydrologic cycle, study of precipitation, evapotranspiration, stream flow, flood flow, ground water, flood routing, snowmelt, and hydrometerology. (3 s.h.)

EWRE 279 Economics and Law of Air and Water Resources - Economics of air and water resource conservation and development, water rights, public policy and laws relating to air and water resources. (3 s.h.)

EWRE 280 Atmospheric Pollution - Fundamentals of atmospheric pollution and control. Sources and nature of gaseous and particulate air pollutants, relation of meteorological conditions to their dispersal and their effects on health and materials are discussed along with administration, standards, and control of air pollution. (3 s.h.)

EWRE 295 Solid Waste Management - Introduction to problems of solid waste practice; types and quantities of wastes; composting, landfill, incineration; recycling of wastes and product recovery; resource management systems. (3 s.h.)

EWRE 300 Water Quality Management - Effects of physical, chemical, biological, and physiological pollutants in streams, reservoirs, and estuaries; fate of pollutants in the environment; water quality criteria; water quality management methodology. Biological aspects of water quality control. (3 s.h.)

EWRE 318 Systems Analysis for Environmental Engineers - Differential equation models derived from basic principles of heat, mass, and momentum transport, reaction kinetics, and mixing and blending. Digital and analog computers to obtain solutions to equations derived. Application of differential equations to problems such as the dispersal of pollutants in rivers. (3 s.h.)

EWRE 321 Water Treatment Theory and Practice - Drinking water standards, advanced study of theory of operation of water treatment operations and processes, relation of theory and design practice analysis and design of water treatment units. (3 s.h.)

EWRE 322 Waste Treatment Theory and Practice - Theory and practice of biological waste treatment. Treatment of municipal and industrial wastewaters by biological processes. Design and operation of biological waste treatment facilities. Principles and practice of sludge dewatering and disposal. Advanced wastewater treatment. Analysis and design of waste water treatment systems. (3 s.h.)

EWRE 333 Air Pollution Control - Design and operation of air pollution control equipment. Method of application of control in various industries. (3 s.h.)

EWRE 334 Air Pollution Meteorology - Basic meteorology of urban atmosphere and effects on air pollution. Structure and properties of atmospheric boundary layer; atmospheric turbulence and diffusion; isolated point, line, volume, and area sources; buoyant plume rise; building effects; urban climatology and meteorology; urban air pollution models. (3 s.h.)

EWRE 345 Water Resources Engineering - Case studies of important problems in water resources engineering. Topics covered may include stratified flow, thermal pollution, eutrophication, tracer techniques, optimization techniques, submerged jets, hydraulic models, water power engineering, and water resources planning. (3 s.h.)

EWRE 362 Management of Solid Waste Collection Systems - Selected problems pertaining to reference materials, methods of collection, methods of storage, equipment, and transportation. A comparison of municipal, contract, and private collection systems. Financing refuse collection operations, organization, personnel, equipment management, cost accounting and budgeting, and public relations. Analysis and planning of refuse collection systems. (3 s.h.)

EWRE 363 The Management of Solid Waste Disposal Systems - Quantities and composition of refuse, selecting disposal methods, sanitary landfill, analysis of central incineration, composting, salvage, reuse, reclamation, reprocessing, and recycling. Design and analysis of refuse disposal systems. (3 s.h.)

INSTITUTION: VANDERBILT UNIVERSITY

PROGRAM: Environmental Science

DEPARTMENT: Environmental Engineering and Policy Management

DEGREE: Bachelor of Science (B.S.)

CONTACT: Dr. Karl B. Schnelle, Jr., Chairman
Department of Environmental Engineering and Policy Managment
Vanderbilt University
Nashville, Tennessee 37240
(615) 322-4757

PROGRAM DESCRIPTION:

PROGRAM STURUCTURE

The program in environmental science is designed for those students who are interested in the application of basic science to environmental problems. Many areas of environmental studies are dealt with, including social science, and it includes an in-depth sequence in the basic science of primary interest.

Environmental matters and problems first received attention in the form of a program in 1962. Environmental Engineering and Policy Management (not the original department title) became a department five years later in 1967, offering a B.S. degree. It is important to realize that this department has undergone a tremendous amount of change; there have been six major upheavals since it was first identified as a department. In addition to the B.S. degree, an Engineers' Council for Professional Development accredited B.E. degree in Environmental and Water Resources Engineering (EWRE) is also offered and the largest portion of undergraduate enrollment is in pursuit of the B.E.

The B.S. degree leads to careers in environmental studies, management, or research, with possibilities in both laboratory and field work, or to further study in management, business or law. These graduates are most commonly placed as laboratory analysts, sanitarians, and public health personnel.

Extensive facilities exist for instruction and research. There is modern equipment for chemical, physical and biological analysis of water, wastewater, air, and solid waste located in the EWRE laboratories. The computation laboratory includes a quantitative analog computer and two teletype units for access to the time-sharing digital computer system.

PROGRAM REQUIREMENTS

The School of Engineering bases its decisions on who shall be admitted upon the personal and academic records of the applicants. Applicants should have had at least four units (a unit representing one year's study in a single subject) of high school English, four units of mathematics (algebra, geometry and trigonometry), and two units of science. Also desirable are two units of a foreign language and one of history. In all, there should be fifteen academic units. Applicants must also submit scores received on the SAT (preferred) or ACT examination. Regardless of which of the entrance examinations is taken, all applicants must also take the College Entrance Examination Board achievement tests Mathematics Level I or II and English Composition.

One hundred and twenty-four semester hours are required for the Bachelor of Science in Environmental Science. Students are expected to take charge of their own programs, which should meet their own needs, show purpose, and display appropriate breadth and depth in coverage of the topic. Students have the assistance of faculty advisors when planning curricula.

Fifteen semester credits must be taken of humanities-social science electives, three credits in technology-society, twenty-eight credits of technical electives, and six credits of free electives. A sample of an acceptable curriculum might include eleven credits of chemistry, eleven of geometry and calculus, five to seven credits of engineering principles, four of either botany or zoology, eight of physics, three of statistics and three of computing. In addition to the required electives in each given area and the mathematics and science background, one might take the following major courses: EWRE 151 - Special Topics on Man and His Environment, EWRE 220 - Environmental Problems: Air Pollution and Occupational Health, EWRE 271 - Environmental Chemistry, EWRE 211 - Water and Wastewater Treatment, EWRE 270 - Public Health Engineering, EWRE 272 - Microbiology of Water, Wastewater, and Air, EWRE 200 - Individual Study, EWRE 222 - Methods in Scientific Research, and EWRE 279 - Economics and Law of Air and Water Resources. The technical electives must include nine hours beyond the minimum requirements on one area of science, such as mathematics, statistics, biology, chemistry, geology, or physics.

CURRENT FACULTY, STUDENTS, GRADUATES

There are the equivalent of nine full-time faculty, including the chairman, in this department with the primary attention on teaching. There are nine persons enrolled in the B.S. program, compared to thirty-four in the B.E. In 1975 there were eleven students pursuing the B.S. and in 1976 there were seventeen. Two or three people are awarded the Bachelor of Science in Environmental Science per year.

On a competitive basis, students may apply for a number of scholarships in the School of Engineering. Although a co-op program does exist in the School of Engineering, it is not widely utilized in this department.

A survey of all graduates of this department shows that nearly 40 percent are employed by the Environmental Protection Agency, 25 percent by state government, 10 percent by the federal government and another 25 percent by private industry.

PROGRAM PROJECTION

This department has undergone six complete changes since its inception; as a result, the department is striving to achieve internal stability. It is hoped that enrollment figures will continue to grow at a moderate rate.

COURSE DESCRIPTION

EWRE 150 Man and His Environment - Scientific and engineering principles for enhancement of quality of the total environment emphasis on role of technology and its interrelationships with society. (3 s.h.)

EWRE 151 Special Topics on Man and His Environment - Discussion, readings, and projects in selected areas of environmental concern. (3 s.h.)

EWRE 210 Water Supply and Wastewater Collection - Hydrologic consideration of surface and ground water sources, design of distribution systems, impoundments, and control works. Hydraulics of water supply systems and sewerage works and appurtenances. Functional design of storm and sanitary sewer systems. (3 s.h.)

EWRE 211 Water and Wastewater Treatment - Water quality criteria, unit operations, and processes of water treatment. Chemical and biological characteristics of wastewater; unit operations, and processes of wastewater treatment; stream pollution. (3 s.h.)

EWRE 220 Environmental Problems: Air Pollution and Occupational Health - Intermediate-level consideration of subjects of air pollution and occupational health; sources of air pollution, meteorological aspects, effects, methods of measurement, and control of air pollution. (1-2 s.h.)

EWRE 221 Environmental Problems: Solid Wastes and Radiological Health - Intermediate-level consideration of subjects of solid wastes and radiological health; the collection, storage, volume reduction, reclamation, and final disposal of wastes. (1-2 s.h.)

EWRE 246 Solid Waste Collection Practice - Refuse collection problems, preparation of refuse for collection, methods, equipment planning, transportations, and finance. Organization, personnel management and public relations. (2 s.h.)

EWRE 247 Municipal Refuse Disposal Practice - Quantities and composition of refuse, disposal methods and management. (2 s.h.)

EWRE 271 Environmental Chemistry - Theoretical aspects of organic and inorganic chemistry applied to environmental engineering problems. (3 s.h.)

EWRE 272 Microbiology of Water, Waste Water, and Air - Emphasis on microbiology of air, water, sewage, and industrial wastes. (4 s.h.)

EWRE 273 Environmental Chemistry Laboratory - Chemical analysis of water and waste water and control of water purification and waste water treatment processes. (3 s.h.)

EWRE 276 Ground Water Hydrology - Occurrence and flow of ground water. Basic concepts of permeability and capillarity. (3 s.h.)

EWRE 277 Open Channel Hydraulics - Resistance in open channels. Hydraulic design of channels. Steady and unsteady non-uniform flows - characteristics and numerical solutions. (3 s.h.)

EWRE 279 Economics and Law of Air and Water Resources - Economics of air and water resource conservation and development, water rights, public policy and laws relating to air and water resources. (3 s.h.)

EWRE 280 Atmospheric Pollution - Fundamentals of atmospheric pollution and control. (3 s.h.)

EWRE 281 Sampling and Analysis of Polluted Atmospheres - Photochemical effects and kinetics of polluted atmospheres. Modern methods of detection of air pollutants by laboratory and continuous analysis. (2 s.h.)

EWRE 295 Solid Waste Mangement - Solid waste management: types and quantities of wastes, collection and transportation of wastes; composting, landfills, incineration; recycling of wastes and product recovery; resource management as a system. (3 s.h.)

INSTITUTION: VANDERBILT UNIVERSITY

PROGRAM: Environmental and Water Resources Engineering (EWRE)

DEPARTMENT: Environmental Engineering and Policy Management

DEGREE: Bachelor of Engineering (B.E.)

CONTACT: Dr. Karl B. Schnelle, Jr., Chairman
Environmental Engineering and Policy Management
Vanderbilt University
Nashville, Tennessee 37240
(615) 322-4757

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This program features a strong foundation in mathematics, basic sciences, the engineering sciences, and engineering design, and includes a choice of advanced-level studies focusing on the use of modern quantitative techniques to solve complex but practical problems in environmental resources management, pollution control, and hydraulic engineering. A joint EWRE-Chemical engineering dual major is also available in this program.

Environmental Engineering and Policy Management became identifiable as a department in 1967, and began as a program five years prior. EWRE's B.E. degree has been offered for the past five years. Since its inception, this degree has become Engineer's Council for Professional Development accredited.

This degree may lead to careers in professional engineering or may provide the foundation for further study in engineering, management, business, or law. These graduates have a design orientation in their approach to problems and are in demand by industry and consulting engineering firms.

The EWRE laboratories are fully equipped with modern equipment for chemical, physical, and biological analysis of water, wastewater, air, and solid waste. They include equipment for study of biological waste treatment, physical-chemical waste treatment, sludge conditioning and filtration, gas stripping, disinfection, air pollution, and other processes. The hydraulics laboratory includes several glass-walled flumes and tanks, temperature controls, automatic measuring and recording equipment, and other devices. All are available for student use in courses, demonstrations, and research. The computation laboratory includes a quantitative analog computer and two teletype units for access to the time-sharing digital computer system.

PROGRAM REQUIREMENTS

Admission eligibility for Vanderbilt's School of Engineering is based on the personal and academic records of the applicants. Candidates must submit academic records showing fifteen academic units (a unit representing one year's study in one subject) with evidence of intellectual ability and promise. At least four units of high school English, four units of mathematics (algebra, geometry, and trigonometry), and two of science prepare the applicant for beginning freshman level engineering courses. Desirable also are two units of a foreign language and one of history. Also required for admission committee review are scores received on the preferred SAT, or on the acceptable ACT examination. Regardless of which of those examinations is taken, all applicants must take the College Entrance Examination Board achievement tests Mathematics Level I or II and English Composition.

Generally, one hundred and twenty-seven semester hours are necessary for completion of the Bachelor of Engineering degree. During the freshman year students must take courses in chemistry, analytical geometry and calculus, elementary physics, engineering principles and resources, and a technology-society elective (EWRE 150 - Man and His Environment is recommended). Courses in economics, differential equations, chemical processes and systems, statico-dynamics, computing, special topics on the human relationship to environment in addition to the continuation of physical chemistry, analytical geometry and calculus, and physics are normally taken during the second year.

Students are expected to take charge of developing their own curricula with the guidance and consent of faculty advisors. These programs must meet the students' needs, show purpose, and display appropriate breadth and depth. A sample of such a program might include courses in fluid mechanics, water resources engineering, water and wastewater treatment, environmental chemistry, microbiology of water and wastewater, and air, public health engineering, economics and law of air and water resources, atmospheric pollution, and solid waste management.

CURRENT FACULTY, STUDENTS, GRADUATES

Including the Chairman, there are the equivalent of nine full-time faculty in this department with their primary responsibility toward instruction. There are thirty-four students enrolled in the B.E. program at the present time. During 1975 there were thirty-two and during 1976 there were forty-six. An average of eight to ten people graduate each year.

The B.E. lays an excellent foundation for advanced study, and a large percentage of the graduates do continue with graduate work. Of all graduates in this department, nearly 40 percent are employed by the Environmental Protection Agency, 25 percent by state government, 10 percent by the federal government, and another 25 percent by private industry.

PROGRAM PROJECTIONS

This department has undergone six major metamorphoses since its inception as a program. It is hoped that there will be moderate increases in enrollment. The overriding goal at this time is one of departmental stability.

COURSE DESCRIPTION

EWRE 150 Man and His Environment - Scientific and engineering principles for enhancement of quality of the total environment, with emphasis on the role of technology and its interrelationships with society. Discussions of air and water pollution; solid waste disposal; urban, rural, and regional problems; water resources and conservation; and future of humans with respect to the environment. (3 s.h.)

EWRE 151 Special Topics on Man and His Environment - Discussions of readings, and projects in selected areas of environmental concern. Students select a section based on their interest. Typical discussion sections offered include: air pollution, solid waste management; water quality in lakes, rivers and reservoirs; microbiology of pollution control; legal and social implications of environmental controls; urban problems; waste and water treatment; and other topics. (3 s.h.)

EWRE 210 Water Supply and Waste Water Collection - Hydrologic consideration of surface and ground water sources, design of distribution systems, impoundments, and control works. Hydraulics of water supply systems and sewerage works and appurtenances. Functional design of storm and sanitary sewer systems. (3 s.h.)

EWRE 211 Water and Waste Water Treatment - Water quality criteria, unit operations, and processes of water treatment. Chemical and biological characteristics of waste water; unit operations, and processes of waste water treatment; stream pollution. (3 s.h.)

EWRE 220 Environmental Problems: Air Pollution and Occupational Health - Intermediate-level consideration of subjects of air pollution and occupational health; sources of air pollution, meteorological aspects, effects, methods of measurement, and control of air pollution. Classification of occupational hazards, toxic action of industrial materials, pulmonary dust diseases, occupational dermatoses, control of particulate and gaseous agents. (1-2 s.h.)

EWRE 221 Environmental Problems: Solid Wastes and Radiological Health - Intermediate-level consideration of subjects of solid wastes and radiological health. (1-2 s.h.)

EWRE 246 Solid Waste Collection Practice - Refuse collection problems, preparation of refuse for collection, methods, equipment planning, transportations, and finance. Organization, personnel management and public relations. (2 s.h.)

EWRE 247 Municipal Refuse Disposal Practice - Quantities and composition of refuse, disposal methods and management. (2 s.h.)

EWRE 270 Public Health Engineering - Principles of public health engineering, study of vector control. (2 s.h.)

EWRE 271 Environmental Chemistry - Theoretical aspects of organic and inorganic chemistry applied to environmental engineering problems. (3 s.h.)

EWRE 272 Microbiology of Water, Waste Water, and Air - Emphasis on microbiology of air, water, sewage, and industrial wastes. (4 s.h.)

EWRE 273 Environmental Chemistry Laboratory - Chemical analysis of water and waste water and control of water purification and waste water treatment processes. (3 s.h.)

EWRE 276 Ground Water Hydrology - Occurrence and flow of ground water. Basic concepts of permeability and capillarity. (3 s.h.)

EWRE 277 Open Channel Hydraulics - Resistance in open channels. Hydraulic design of channels. Steady and unsteady non-uniform flows - characteristics and numerical solutions. (3 s.h.)

EWRE 279 Economics and Law of Air and Water Resources - Economics of air and water resource conservation and development, water rights, public policy and laws relating to air and water resources. (3 s.h.)

EWRE 280 Atmospheric Pollution - Fundamentals of atmospheric pollution and control. Sources and nature of gaseous and particulate air pollutants. (3 s.h.)

EWRE 281 Sampling and Analysis of Polluted Atmospheres - Photochemical effects and kinetics of polluted atmospheres. Modern methods of detection of air pollutants by laboratory and continuous analysis. (2 s.h.)

EWRE 295 Solid Waste Management - Solid waste management: types and quantities of wastes, collection and transportation of wastes; composting, landfills, incineration, recycling of wastes, and product recovery; resource management as a system. (3 s.h.)

INSTITUTION: VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

PROGRAM: Sanitary Engineering/Environmental Sciences and Engineering/Civil Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Paul H. King
Chairman, Environmental Sciences and Engineering
Civil Engineering Department
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061
(703) 951-6131

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental sciences and engineering/Civil engineering/ Sanitary engineering at VPI consists of five degree programs, all interrelated and designed to prepare students with a good background in several areas of environmental control. Sanitary engineering was initiated at VPI in 1945 and the environmental engineering programs established in 1968.

The environmental sciences and engineering program offers the broadest range of training, preparing students in air pollution control, water supply, and waste water. This program is designed primarily for students with undergraduate degrees in the physical or life sciences, rather than engineering. Both a Master's Degree and a Ph.D are offered in this program.

Sanitary engineering and civil engineering are water quality oriented programs and are designed for students with undergraduate degrees in engineering. Master's Degrees are offered in both Sanitary Engineering and in Civil Engineering with majors in hydraulic engineering, sanitary engineering, and water resources engineering. A Ph.D. is offered in Civil Engineering with majors in hydraulic or water resources engineering and Sanitary Engineering.

The programs are supported not only by the university but through outside funding sources such as EPA research and training grants, state environmental funds, and the federal Office of Water Research and Technology (Dept. of the Interior). In addition, the programs have their own laboratory facilities including a joint facility with the plant pathology department on effects of air pollution and a water monitoring field laboratory in Northern Virginia.

PROGRAM REQUIREMENTS

Requirements for all the M.S. programs generally include an undergraduate degree from an accredited program with an average of 2.7/4 or higher. It is preferred that students in the engineering programs have undergraduate degrees in civil, mechanical, chemical, or agricultural engineering, while environmental sciences students may have degrees in an engineering discipline or in a physical or life science.

Admission to the Ph.D. program generally requires a Master's Degree in engineering or in the case of environmental sciences, an M.S. in a physical or life science.

Degree requirements in the M.S. programs require a minimum of forty-five quarter hours, with nine to fifteen hours applied to a thesis. The engineering programs require nine credit hours in design, six in chemistry, four in microbiology, and three in analysis laboratory. The requirements in environmental science are the same except for the substitution of nine hours in the student's primary discipline in lieu of design.

The Ph.D. requirements include one hundred and thirty five quarter hours, of which between fifty and seventy may be applied to research and dissertation. Students must also demonstrate proficiency in reading one foreign language or complete an additional six credit hours in non-technical electives.

CURRENT FACULTY, STUDENTS, GRADUATES

There are seven faculty members participating in these programs, five of whom primarily teach, and two of whom are principally concerned with research. In addition, six other faculty members teach some courses in the program. The environmental sciences program draws upon faculty from other departments such as aerospace and ocean engineering, agricultural engineering, mining engineering, biology, chemistry, forestry and wildlife, and statistics.

Currently, there are fifteen full-time and three part-time students in the sanitary engineering M.S. program, fifteen full-time and two part-time in the environmental sciences M.S. program, and five in the Civil Engineering M.S. program in environmental options. There are also four students in each of the two Ph.D. programs.

Approximately sixty percent of the students come from Virginia and come to VPI through various recruiting methods such as alumni contacts, program flyers and listing in Peterson's Guide. About sixty percent of the students receive some form of financial aid which currently includes six EPA training grants, six teaching assistantships, six research assistantships, three fellowships, and four grants from the state which pay one-half salary plus tuition for employees.

Most graduates directly enter the workforce rather than continuing on to further degrees. It is estimated that about ninety percent find employment in their field, with about fifty percent going to the private sector, forty percent into government jobs, and the remainder into other positions such as teaching and research. Graduates are generally placed in positions through faculty contacts with employers.

PROGRAM PROJECTIONS

It is anticipated that current program levels will be maintained and that there is no need for expansion at this time. There is the possibility of adding one faculty member, specializing in water programs, in the next two years.

ADDITIONAL INFORMATION

Program faculty members conduct short courses each year for the Virginia State Water Control Board. This includes an operator training program each summer in which about four hundred operators receive training in preparation for state certification.

COURSE DESCRIPTION (SELECTED)

CE 4260 Introduction to Air Pollution - Scientific, engineering and legal aspects of air pollution with remedies and controls. (3 q.h.)

CE 4041, 4042, 4043 Sanitary Engineering - Processes for water purification and sewage treatment. (3 q.h.)

CE 5100 Advanced Sanitary Engineering - Principles of organic chemistry and biochemistry as applied to sanitary engineering systems. (3 q.h.)

CE 5230 Water Quality Waste Treatment - Advanced methods for research in biological and chemical treatment processes. (3 q.h.)

CE 5121 Sanitary Engineering Design - Design of treatment components and systems. (3 q.h.)

CE 5131 Public Health Engineering - Environmental sanitation, epidemiology, milk and food sanitation, solid waste disposal, industrial hygiene. (3 q.h.)

CE 5093 Air Pollution - Facilities and techniques for design of control programs for air pollution. (3 q.h.)

CE 5400 Solid Waste Practices - Current solid waste management practices. (3 q.h.)

CE 5082 Water Resources Engineering - Water resources planning, economics of water resource developments. (3 q.h.)

CE 5083 Water Resources Engineering - Design of water resources systems. (3 q.h.)

CE 6062 Advanced Engineering Hydraulics - Potential flow theory; boundary layers; turbulence; application in hydraulic design. (3 q.h.)

Stat 5090 Stochastic Modeling of Pollution: Water - Development and evaluation of stochastic models used in water pollution; dynamic regression, and stochastic models will be developed for several biodegradable processes. (3 q.h.)

Biol 5050 Environmental Science Water - Interdisciplinary seminar course in pollution assessment, waste treatment, aquatic communities, bioassays of toxicants, application factors for disposal of toxicants, problems of pollution control legislation. (2 q.h.)

Biol 5060 Water Resource Management - Seminar course, primarily for ecology and sanitary engineering, to discuss current problems and research in both fields. (2 q.h.)

Geol 4110 Ground Water Hydrology - Sources, occurrence, inventory, utilization, and recharge of ground water in the earth's crust. (3 q.h.)

Geol 4400 Environmental Geology - Applications of geologic knowledge to problems and activities associated with urban and regional development: water resources, mineral resources, waste disposal, subsurface storage, construction and physical planning. (3 q.h.)

INSTITUTION: WEST VIRGINIA UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Civil Engineering
Master of Science in Engineering

CONTACT: Dr. William J. Wilhelm, P.E.
Professor and Chairman of Civil Engineering
Civil Engineering Department
West Virginia University
Morgantown, West Virginia 26505
(304) 293-3867

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental engineering program of the Civil Engineering Department at West Virginia University was long oriented toward sanitary engineering and hydraulics. The program was constructed mainly between 1962 and 1967. In 1963 air pollution courses were incorporated and in 1967 solid waste courses were added. In 1976, the program was expanded with the addition of water resources courses. Because at the graduate level no rigid curriculum is prescribed for the degrees of Master of Science in Civil Engineering and Master of Science in Engineering, students may specialize in two or more specialty areas. Specialties are offered in air pollution control, solid waste management, water and wastewater treatment and water resources.

Students choosing to specialize in air pollution control and abatement are prepared to assume positions in local, state or federal regulatory agencies. Many students specializing in the water areas have found positions with industrial firms (eg. Union Carbide) or with consulting firms.

PROGRAM REQUIREMENTS

In order to enter Graduate School at West Virginia University, applicants with a baccalaureate degree, or its equivalent, from a department accredited by the Engineer's Council for Professional Development (ECPD) will be admitted on the same basis as engineering graduates of the University. If these requirements (ECPD) are not fulfilled, then the applicants must first fulfill the requirements of the department in which the advanced degree is sought.

For the Master of Science in Engineering degree, each candidate must fulfill a planned program conforming to one of the following (with the approval and discretion of the graduate committee):

(1) A minimum of 30 semester credits hours, not more than 6 of which are in research leading to an acceptable thesis.
(2) A minimum of 33 semester credit hours, not more than 3 of which are in research leading to an acceptable problem report.
(3) A minimum of 36 semester credit hours, with no thesis or problem report required.

A thesis or problem report is normally required of all candidates and a candidate shall be required to pass an examination which may be written, oral, or both, to be administered by the student's advisory and examining committee. Depending on the program followed, the examination covers course material and the thesis or problem report.

No rigid curriculum is required for the Master of Science in Civil Engineering and Master of Science in Engineering degrees. At least fifteen semester hours credit should normally be selected from graduate civil engineering courses. Only those holding a baccalaureate degree in civil engineering are allowed to complete the requirements for the Master of Science in Civil Engineering degree. The Master of Science in Engineering degree is available to students who enter the graduate program but do not possess a baccalaureate degree in civil engineering.

Financial assistance available to graduate students enrolled in the environmental engineering program include: U.S. EPA air pollution training grants; contract research (research assistantships); one-half time teaching fellows; National Science Foundation Coal-Energy Traineeships; and West Virginia University foundation fellowships.

CURRENT FACULTY, STUDENTS, GRADUATES

Five full-time faculty members teach the bulk of the environmental engineering courses. Assistance is provided by three adjunct professors funded through the National Institute for Occupational Safety and Health. Approximately one-half of their time is devoted to teaching and one-fourth time each devotes to research and professional activities. Current research projects they are involved with include two Department of Energy (ERDA) projects and one million dollars of state money for two projects concerning air pollution control and acid mine coal drainage control.

There are currently twenty graduate students enrolled full-time in the program and all except three are male students. There are no part-time graduate students enrolled in the program. Ten students have been graduating annually in recent years in the Master's programs. Enrollment has been rather stable over the past several years.

Few graduate students enrolled in this program continue on for additional degrees. About ninety percent find employment in their field and ten percent in a related field. Recent employment trends indicate that most graduates (75 percent) find government jobs and only 25 percent find jobs in the private sector.

PROGRAM PROJECTIONS

There is not expected to be any significant growth in this program in the next several years. Expansion primarily depends on what government research is needed in the next few years. No faculty changes are also anticipated. At West Virginia University there is an attempt to develop an Environmental Health Science Program on campus. Program officials continue to foresee environmental programs continuing to be strong as long as the federal government continues to put funds into programs through research.

COURSE DESCRIPTION (SELECTED)

146 Sanitary Engineering I - Hydrology as applied to water and waste systems. (3 s.h.)

147 Sanitary Engineering II - Examination of water and waste water, water treatment, waste water treatment and special problems in public health, air pollution, and radioactivity. (3 s.h.)

251 Public Health Engineering - Engineering aspects involved in control of the environment for the protection of health and promotion of comfort of man. (3 s.h.)

252 Water Resources Engineering - Design of water resources systems. (3 s.h.)

345 Properties of Air Pollutants - Physical, chemical, biological, and social behavioral properties of dusts, droplets, and gases in the atmosphere. (3 s.h.)

349 Solid Waste Disposal - Study of traditional patterns and problems of solid waste storage, transport, and disposal. Examination of various engineering alternatives with appropriate consideration for air and water pollution control and land reclamation. (3 s.h.)

350 Sanitary Chemistry and Biology - Theory and methods of chemical analysis of water, sewage, and industrial wastes. Biological aspects of stream pollution problems. (3 s.h.)

356 Principles of Biological Waste Treatment - Examination of biological systems used in waste treatment as to ecology and function. (3 s.h.)

446 Air Pollution Control Engineering - Study of engineering alternatives in achieving various degrees of air pollution control. (3 s.h.)

447 Air Pollution Control Standards - Comparative study of technical, economical, and social factors used in developing and establishing air pollution standards, criteria, and control limitations. (3 s.h.)

452 Water Treatment Theory - Theory of various procedures and techniques utilized in treatment of water for municipal and industrial use. (3 s.h.)

454 Industrial and Advanced Waste Treatment - Basic physical and chemical operations used in industrial and advanced waste treatment; applications for waste water reclamation and reuse; study of industrial wastes from standpoint of process, source, and treatment. (3 s.h.)

455 Municipal and Industrial Design of Solid Wastes Disposal Operations - Design criteria of existing methods and equipment for disposal of solid wastes generated by industry and municipalities: on-site preparation. (3 s.h.)

457 Hydraulics of Sanitary Engineering Works - Techniques of population growth estimation, rainfall and runoff analysis, flood flow, and ground water data to the design of sanitary works. (3 s.h.)

458 Design of Sanitary Works - Water supply and waste water disposal problems. (3 s.h.)

INSTITUTION: WESTERN KENTUCKY UNIVERSITY

PROGRAM: Environmental Engineering Technology

DEPARTMENT: Engineering Technology

DEGREE: Bachelor of Science

CONTACT: Boyce D. Tate, P.E., Head
Department of Engineering Technology
Western Kentucky University
Bowling Green, Kentucky 42101
(502) 745-2461

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Prior to the time of this program's inception (1969) a survey of industries was conducted in order to identify the skills and academic backgrounds which would make graduates valuable to industry in the field of environmental engineering technology. The results of this survey were important in the development of the curriculum.

This was the first B.S. program in environmental engineering technology to be accredited by the Engineers' Council for Professional Development. In the past such an accreditation was awarded exclusively to two-year programs. In addition to the self-study information, which was necessary for preparation of the accreditation report, the department sent questionnaires to the employers of former students to assist them in the appraisal of the effectiveness of training received at WKU.

Graduates are qualified environmental consultants, air pollution specialists, water pollution specialists, water and wastewater plant operators and, more traditionally, sanitarians.

A new building houses the well equipped environmental laboratories and part of the classrooms. This new facility is designated for environmental studies. Faculty offices and more classrooms are across the street in the engineering building.

PROGRAM REQUIREMENTS

Graduates of Kentucky high schools are unconditionally admitted to the freshman class, while out-of-state applicants must rank in the top half of their graduating class, have a 2.0 average in a college preparatory program, and have satisfactory ACT scores.

Students must complete six semester credits of English, eleven credits of mathematics, three credits of computer science, twelve of chemistry, eight of physics, seven of biology, three of economics, three of industrial education, three of geology. General studies electives account for twenty-seven credits and the major requirement consists of forty-nine hours of engineering technology and environmental engineering technology. The entire program requires one hundred and thirty-two semester hours for graduation with the B.S. degree.

CURRENT FACULTY, STUDENTS, GRADUATES

Two full-time faculty members coordinate both this program and one entitled Environmental Science (also in the Department of Engineering Technology). Seven other faculty members from other areas of engineering provide part-time support by teaching courses. Faculty growth often occurs through the hiring of persons with expertise in both environmental engineering technology and one other engineering discipline, the result being a joint appointment.

There are forty students currently enrolled in this option. Many of the students have transferred from junior colleges upon completion of an associate degree. Eight students will graduate in June, 1978.

Because employers are not always aware of the nature of the skills these graduates possess, they are slow to hire them. Eventually, all graduates from past classes have found related placements, but not without first taking considerable initiative. Follow-up data show 42 percent seek advanced degrees, 37 percent are employed in private engineering and consulting firms, and 43 percent are working in government positions.

PROGRAM PROJECTIONS

In the near future a coop arrangement will begin. It is felt that this work experience will greatly enhance the hireability of graduates.

Plans for tracks within this option are gelling. Soon students will be able to specialize in water and wastewater engineering technology. Later, tracks in air pollution management, solid waste management, industrial hygiene, and radiation protection will be offered.

COURSE DESCRIPTION

ET 280 Introduction to Environmental Studies - Introduction to the basic concepts and language of population, air pollution, water pollution, environmental radiation, solid waste, disposal and other environmental problems. (3 s.h.)

ET 360 Air Pollution Control - Sources, effects, air quality criteria and standards, monitoring and control of air contaminants. (3 s.h.)

ET 475 Air Pollution Control Lab - Monitoring for particulates and gaseous contaminants: settleable and suspended particulates and gases (SO_2, NO, NO_2, O_x, CO). (1 s.h.)

ET 410 Water Supply - Design of collection, purification, and water distribution facilities. (3 s.h.)

ET 415 Water Supply Lab - Monitoring for physical, chemical and biological characteristics of a water supply as well as field trips to water treatment plants. (1 s.h.)

ET 420 Wastwater Treatment - Design of collection, treatment and disposal systems for wastewater. (3 s.h.)

ET 425 Wastewater Lab - Unit processes and unit operations for aerobic and anaerobic systems coupled with monitoring for the significant operating parameters. (1 s.h.)

ET 430 Radiological Health - Fundamentals of atomic, nuclear and radiation physics as related to radiological health. (3 s.h.)

ET 475 Radiological Health Lab - Fundamentals of detection of ionizing radiation, including X and gamma radiations, alpha and beta particles. (1 s.h.)

ET 440 Industrial Hygiene - Fundamental principles of occupational health and emphasizes recognition, evaluation and control of occupational health hazards. (3 s.h.)

ET 470 Industrial Waste Treatment - Design-orientation for the application of preliminary, primary, secondary, and advanced water treatment processes for industrial discharge. (3 s.h.)

ET 480 Solid Waste Treatment - Practice and technology of solid waste collection and disposal, including sanitary landfill, incineration, composting, recycling and recent developments. (3 s.h.)

ET 490 Sanitation - Sanitary principles involved in the production and processing of milk, milk products, and food, including sanitary codes and inspection procedures. Swimming pools and housing included. (3 s.h.)

ET 495 Environmental Impact Statement - An understanding of procedure and details in preparation and review of environmental impact statements. (3 s.h.)

INSTITUTION: WESTERN KENTUCKY UNIVERSITY

PROGRAM: Environmental Science

DEPARTMENT: Engineering Technology

DEGREE: Bachelor of Science

CONTACT: Boyce D. Tate, Head
Department of Engineering Technology
Western Kentucky University
Bowling Green, Kentucky 42101
(502) 745-2461

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental Science was conceptualized and formally approved during the fall of the 1973-1974 academic year. It replaces the previous Environmental Health program, and was developed as a companion to the Environmental Engineering Technology program. The curriculum is sufficiently flexible as to allow the opportunity to pursue a number of interests in the environmental area including air pollution, water pollution, radiation protection, occupational health and others.

A new building, which is designated specifically for environmental studies, houses well-equipped environmental laboratories and several of the classrooms. Faculty offices and the remainder of the classrooms are located across the street in the engineering building.

Graduates are qualified environmental specialists with expertise in occupational health, radiation protection, air pollution, water pollution, and environmental assessments (i.e., environmental impact statements). In part, the reason for the change from Environmental Health to Environmental Science was a function of graduates having no placement opportunities except as sanitarians; the current program provides greater occupational diversity.

PROGRAM REQUIREMENTS

Graduates of Kentucky high schools are unconditionally admitted to the freshman class, while out-of-state applicants must rank in the top half of their graduating class, have a 2.0 average in a college preparatory program, and have a satisfactory ACT score.

The Environmental Science curriculum includes an area of concentration consisting of fifty-two/fifty-three semester hours in the student's specialty field and is formulated around four course groupings. The first core is composed of thirty-nine/forty hours of humanities, social and behavioral studies, physical development, and organization and communication of ideas. Thirty-seven hours of basic sciences serve as the principle group of prerequisite courses for the specialty area and provide a foundation in traditional science areas.

The principal problem areas of the environmental field are included in the environmental area core, emphasizing the aspects of evaluation and control of the various environmental hazards. A strong laboratory orientation is an important feature of this option, and it provides direct experience with the parameters and measurements important in the various areas. Twenty-seven to twenty-eight credits dealing with air pollution, water pollution, sanitation, solid wastes, industrial hygiene, radiological health, and environmental impact assessments compose this segment of the curriculum.

The final core (twenty-seven to twenty-nine semester hours) provides the flexibility which permits students to outline their own track, or specialty. The approved electives are intended to allow a student who is interested in a particular environmental topic area to select courses from other science areas that lend support to his/her interest.

CURRENT FACULTY, STUDENTS, GRADUATES

Two full-time faculty coordinate both this program and its companion, Environmental Engineering Technology. Part-time teaching support comes from the seven full-time faculty in the various other disciplines of the Department of Engineering Technology.

Although the enrollment has demonstrated a steady increase from the initial twelve students to the current thirty-seven, it is still felt that recruitment efforts need to be made. Seven people graduated in 1977. There has been a total of nineteen graduates in this option.

While there has been no formal follow-up survey conducted, personal contact has located all but one of the former students. Forty-two percent have continued their educations in advanced degree programs, 37 percent found positions in private companies (predominantly consulting firms), and 21 percent were employed by the government.

PROGRAM PROJECTIONS

Shortly, two tracks will be considered, one in industrial hygiene and the other in radiation protection. Additional faculty would be desirable, but the expertise to begin each of these tracks at the current staffing level does exist.

The realization of such options relies heavily on the continued growth of student enrollment and on eventually securing new faculty, the most critical determinant being the enrollment increase. There is now a substantial recruitment effort taking place.

COURSE DESCRIPTION

ET 107 Introduction to Engineering Technology - Introduction to the various specialties in engineering technology, careers and opportunities. Reviews technical competence expected of engineering technicians and technologists. (1 s.h.)

ET 280 Introduction to Environmental Studies - Physical, chemical and biological parameters of the environment. Basic concepts and language of population, air pollution, water pollution, environmental radiation, solid waste disposal and other environmental topics. (3 s.h.)

ET 360 Air Pollution Control - Demonstration of basic air pollution monitoring equipment. Air pollution sources, nature and behavior of air pollutants, air sampling and analysis, dispersion and diffusion in the atmosphere, the effects of weather on air pollution, air pollution surveys, physiological effects, and methods and equipment for community air pollution control. (3 s.h.)

ET 410 Water Supply - Planning, operation and design of water supply systems. Water consumption and supply, water quality standards and criteria, population predictions, hydrological considerations of surface and ground water. Design of collection, purification and water distribution systems. Testing procedures for water quality surveys and water treatment plant operation. (3 s.h.)

ET 415 Water Supply Laboratory - Laboratory course correlated with ET 410. (1 s.h.)

ET 420 Waste Water Treatment - Theory, design and operation of waste water collection and disposal systems, considered as unit operations and unit processes. Functional design of storm and sanitary sewers, sewage works and appurtenances. Chemical and biological characteristics of waste water. (3 s.h.)

ET 425 Waste Water Treatment Laboratory - Laboratory course correlated with ET 420. (1 s.h.)

ET 430 Radiological Health - Fundamentals of atomic, nuclear and radiation physics as related to radiological health. Fundamentals of detection of ionizing radiation, including X and gamma radiations, alpha and beta particles and neutrons. Counting techniques, statistics, radiation interaction, biological effects, radiation hazards (maximum permissible concentration and dose) and radioactive waste disposal. (3 s.h.)

ET 435 Radiological Health Laboratory - A laboratory course correlated with ET 430. (1 s.h.)

ET 440 Industrial Hygiene - Fundamental principles of occupational health and the recognition, evaluation and control of occupational health hazards. Occupational Safety and Health Act of 1970. Industrial health hazards. Reaction of respiratory system to

ET 440 (Cont'd) - particulates and gases. Mode of action of organic and inorganic chemicals such as lead and mercury. Pneumoconiosis. Noise measurement and control. Evaluation of heat stress. Electromagnetic spectrum. Ionizing radiation. Industrial ventilation. Instrumental methods such as x-ray diffraction, gas chromatography and atomic absorption. (3 s.h.)

ET 470 Industrial Waste Treatment - Studies of the characteristics and composition of wastes from industrial processes and their effects on the environment. Methods of sampling and analysis of industrial waste and remedial measures for treatment and disposal. (3 s.h.)

ET 480 Solid Waste Treatment - Extent and characteristics of the solid waste problem. Current practice and new developments in management of solid waste. Physical and chemical composition of refuse disposal, collection methods and disposal methods such as sanitary landfill, incineration, composting, salvage and reclamation. Public health significance of solid waste management. (3 s.h.)

ET 495 Environmental Impact Statements - Preparation of assessments of environmental impacts as outlined by the National Environmental Policy Act (NEPA). (3 s.h.)

INSTITUTION: YALE UNIVERSITY

PROGRAM: Environmental Health

DEPARTMENT: Epidemiology and Public Health

DEGREE: Master of Public Health

CONTACT: Jan Adrianus Jozef Stolwijk, Ph.D.
Professor of Epidemiology (Environmental Health)
Yale University, School of Public Health
Department of Epidemiology and Public Health
60 College Street
New Haven, Connecticut 06510
(203) 562-9901

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The John B. Pierce Laboratory has been affiliated with Yale University since its founding in 1924. Many of the Laboratory's staff hold joint appointments at the University, primarily in the Department of Epidemiology and Public Health. The Pierce Laboratory now conducts a major portion of Yale's program in environmental health. The Laboratory's staff of physiologists, psychologists, and engineers are well known internationally for their studies of how humans respond to the environment, particularly the thermal environment. They also conduct research in air sanitation, thermal physiology, and the mechanisms of related adverse health effects.

Epidemiological and toxicological studies are also conducted by laboratory staff in order to describe and accurately assess the effect of air pollutants on human health, in the occupational and community environment. An ongoing air sanitation research program is concerned with the measurement of acute adverse effects of air pollutants in the New Haven area. Recent research has found that when combined with the blood's capacity to transport oxygen to the body's tissues. The air sanitation laboratory has devices and tools for studies of human responses to air pollution. Air sanitation laboratory staff study the pulmonary function and resistance changes in man and animals resulting from breathing noxious materials and gases.

Yale University's Division of Environmental Health, started in 1967, is concerned with the study and management and control of natural and human caused factors in the environment in their relationship to human health and well-being. Emphasis in the program is placed on providing the students a broad and sound understanding of the source and characteristics of environmental factors and the mechanism of their interaction with people.

Students who participate in the Division of Environmental Health's programs are prepared for employment by governmental and service agencies and by industry. Environmental health graduates are expected to be able to participate in and/or direct the environmental health activities and operations of a governmental, service, or industrial organization. Many graduates become directors of health districts, environmental coordinators of state health departments, sanitarians, and other administrative positions. Governmental administrative positions often are in environmental and occupational health capacities. Others find positions in unions, industry, consulting (research and teaching) and with organizations such as the Environmental Defense Fund and the American Lung Associates.

PROGRAM REQUIREMENTS

The Department of Epidemiology of Public Health requires candidates for the Master of Public Health to possess, in order to be admitted, either: (1) a graduate degree, from an acceptable institution, in a discipline relevant to public health, or (2) a bachelor's degree from an acceptable institution, with a substantial knowledge in a discipline relevant to public health either through study or experience or a combination of these. Candidates are expected to have attained an undergraduate average of B.

Students who have not had prior course work in human physiology will be expected to take Epidemiology and Public Health 111A, The Human Body in Health and Disease. All students are expected to attend the weekly seminar in environmental physiology. For graduation, all students are expected to earn satisfactorily a minimum of sixty credits, including four credits for supervised field training and nine credits for the essay.

The Division of Environmental Health's eleven required courses provide an understanding of the basic interactions between people and their environment as well as an introduction to the control and management techniques. Elective courses give students opportunities to specialize in a selected area of environmental health.
The Division's curriculum is sufficiently flexible to accomplish this. Some students may specialize in the application of control and management techniques, particularly those methods pertaining to the engineering and sanitation aspects of the environment. Research work performed in conjunction with Environmental Health 213 Research in Environmental Health, provides study opportunities to do an in-depth study in a selected area of environmental health. Some of the advanced or specialized courses are taught on a tutorial or semi-tutorial basis with the program of instruction being geared to meet the student's specific needs or interests. Students are also encouraged in the program to elect appropriate courses in other departments and schools of Yale University.

A three month summer practicum is available to students in the program between the first and second years. It affords students an opportunity to obtain "hands on" experience and bring the training gained back to class to share. Students have been sponsored by the EPA, state and local health departments, television and newspaper media and the State of New York. Also, during the second year,students participate in a one day per week practical work experience. In this they are assigned to an employed environmental health person one day a week at local or state health departments. Then they write an essay examining an environmental health problem.

The Department of Epidemiology and Public Health is a participant in the Graduate and Professional School Financial Aid Service and loans and grants are awarded on the basis of need. Two pre-doctoral and two post-doctoral fellowships are available to students in the program and the National Institutes of Health are the funding source. A number of partial traineeships are also available from the Federal government for Master's students.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten faculty members contribute to the teaching and research conducted by the Division of Environmental Health. It is estimated that about 25% of their time is devoted to teaching and 75% to research. All ten are entirely supported by research funding from the National Institutes of Health, the National Science Foundation, the National Aeronautics and Space Administration, the Air Force, the American Society for Health and Engineering and the General Foods Corporation. The National Institute for Environmental Health Science funds a grant for the Division's training program.

A total of twenty students (50% female) are currently enrolled full-time. There are no part-time students enrolled in the Division's program. Ten students annually receive the Master of Public Health degree, on the average. The number of graduates and enrollment have remained stable.

This program is designed to be a terminal program as only the Master's degree is offered. Some students do continue for doctorates, M.D.s and law degrees, however. Most that continue for doctorates do so at schools which have environmental physiology or environmental health programs. Virtually all graduates obtain employment in their field, and it is estimated that one-half enter positions in the private sector and the other one-half find jobs in the public sector. Most obtain occupational health positions.

PROGRAM PROJECTIONS

Although this program is not expected to significantly change in faculty staff size, enrollment, or emphasis, additional continuing education package programs are likely to be developed. These programs will be designed for people already working in the field.

Additional administrative occupational health personnel will probably be recruited to teach community and occupational health courses. These personnel may already have positions as a director of a medical corporation, for example. Additional degree programs will not be developed because doctorates are already offered in the fields of epidemiology, and environmental biostatistics.

Professionals in the field foresee a slow and steady growth in the environmental health field. The new Toxic Substances Control Act requires an enormous need for testing in stages. They feel that this program would work better if expanded because research results could be obtained if the program is doubled. Even if the program was doubled, Yale professionals in the program do not feel that the market would be flooded in the environmental health field.

COURSE DESCRIPTION

100b Introduction to Air Pollution - Principal sources and causes of air pollution, the nature and behavior of air pollutants, the effects of air pollution, and the organization and administration of control measures. (1 s.h. first half term)

112a Water Supply and Waste Water Treatment - A study of the design and operation of water supply systems and waste water treatment systems. (2 s.h.)

113b Solid Waste Management - Consideration of the fundamentals of solid waste collection, storage, processing, and disposal. (1 s.h.)

120a Principles of Radiological Health - Basic problems and programs of environmental and occupational control of ionizing radiation. (1 s.h.)

150b Introduction to Environmental Control - A survey course in environmental control which identifies the various environmental entitities that affect or may affect health and discusses the various methods of control. (2 s.h.)

151 Seminar in Environmental Control and Management - Students and guest lecturers discuss current problems of environmental control and management. (1 s.h. each term)

153b Environmental Control in Community Hygiene I - Subject matter includes air pollution, solid waste, housing and vector control. (4 s.h.)

154a Environmental Control in Community Hygiene II - Subject matter includes water supply and waste water treatment, food and milk sanitation, ionizing radiation. (4 s.h.)

155 Readings in Environmental Health - Study and review of the literature in selected areas of environmental health with particular emphasis upon research and epidemiological studies. (2-4 s.h. each term)

Photo reprinted from the Michigan Technological University Catalog 1975-76

APPENDICES

Photo reprinted from the University of Illinois Institute of Technology Booklet

Photo reprinted from the Indiana University of Public and Environmental Affairs Catalog 1977-78

APPENDIX I

Degree Abbreviations

A.A.	Associate of Arts
A.A.Ag.	Associate of (in) Applied Agriculture
A.Ag.	Associate of (in) Agriculture
A.A.P.C.T.	Associate Degree in Air Pollution Control Technology
A.A.S.	Associate of Applied Science
A.B.	Bachelor of Arts
A.D.	Associate Degree
A.E.T.	Associate in Engineering Technology
A.M.T.	Associate of Mining Technology
A.N.E.T.	Associate of Nuclear Engineering Technology
A.S.	Associate in Science
A.S.E.M.T.	Associate of Science in Engineering Mining Technology
A.T.	Associate of Technology
B.A.	Bachelor of Arts
B.E.M.T.	Bachelor of Engineering in Mining Technology
B.S.	Bachelor of Science
B.S. (N.E.)	Bachelor of Science in Nuclear Engineering
B.S. (N.E.S.)	Bachelor of Science (Nuclear Engineering Sciences)
B.S. (N.R.)	Bachelor of Science in Natural Resources
B.S.A.	Bachelor of Science in Agriculture
B.S.C.E.	Bachelor of Science in Civil Engineering
B.S.Ch.E.	Bachelor of Science in Chemical Engineering
B.S.E.	Bachelor of Science in Engineering
B.S.E.H.	Bachelor of Science in Environmental Health
B.S.E. (N.E.)	Bachelor of Science (Nuclear Engineering)
B.S.E.S.	Bachelor of Science in Engineering Sciences
B.S.N.E.	Bachelor of Science in Nuclear Engineering
B.T.	Bachelor of Technology
Cert.	Certificate

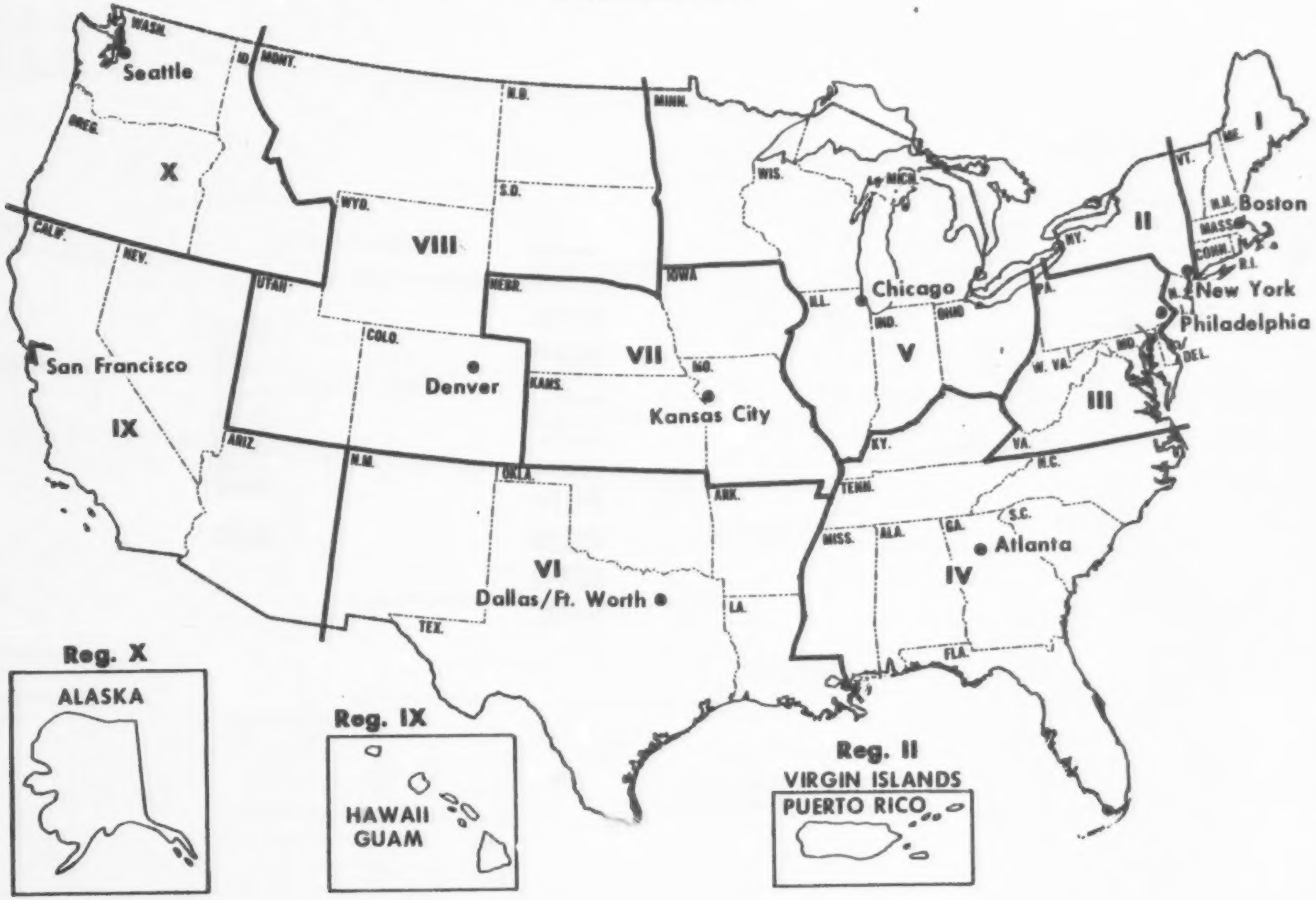
D.E.	Doctor of Engineering
D.P.H.	Doctor of Public Health
D.S.	Doctor of Science
D.S. (Hyg.)	Doctor of Science Hygiene
D.Sc.	Doctor of Science
Dr.P.H.	Doctor of Public Health

E.E.	Environmental Engineer
Eng.	Engineer
Engr.	Engineer
Engr.Sc.D.	Doctor of Engineering Science
Env.E.	Environmental Engineer
Envir.Eng.	Environmental Engineer

M.A.	Master of Arts
M.Ag.	Master of Agriculture
M.Agr.	Master of Agriculture
M.A.S.	Master of Applied Science
M.C.E.	Master of Civil Engineering
M.E.	Master of Engineering
M.E.E.E.	Master of Engineering in Environmental Engineering
M.E.A.S.	Master of Environmental Arts and Science
M.E.H.S.	Master of Environmental Health Sciences
M.E.M.	Master of Environmental Management
M.E.P.C.	Master in Environmental Pollution Control
M.Eng.	Master of Engineering
M.Engr.	Master of Engineering
M.F.	Master of Forestry
M.M.E.	Master of Mechanical Engineering
M.P.	Master of Philosophy
M.P.A.	Master of Public Affairs
M.P.H.	Master of Public Health
M.P.P.P.M.	Master of Plant Protection and Pest Management

M.P.S.	Master of Professional Studies
M.S.	Master of Science
M.S. (Hyg.)	Master of Science Hygiene
M.S.C.E.	Master of Science in Civil Engineering
M.S.Ch.E.	Master of Science in Chemical Engineering
M.S.E.	Master of Science in Engineering
M.S.E.E.	Master of Science in Environmental Engineering
M.S.En.E.	Master of Science in Environmental Engineering
M.S.Eng. S.	Master of Science in Environmental Engineering
M.S.Eng. Sci.	Master of Science in Engineering Science
M.S.E.H.	Master of Science in Environmental Health
M.S.E.M.P.	Master of Science in Energy Management and Policy
M.S.E.S.	Master of Science in Environmental Science (Studies)
M.S.P.H.	Master of Science in Public Health
M.S.(S.E.)	Master of Science in Sanitary Engineering
M.S.(S.S.)	Master of Science in Sanitary Science
N.E.	Nuclear Engineering
Nuc. Eng.	Nuclear Engineering
Ph.D.	Doctor of Philosophy
S.B.	Bachelor of Science
Sc.D.	Doctor of Science
S.M.	Master of Science

STANDARD REGIONAL BOUNDARIES
TEN REGIONS


WASH.
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ILL.
Chicago
PA.
N.J.
New York
IND.
OHIO
Philadelphia
COLO.
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W. VA.
MD.
DEL.
San Francisco
Denver
KANS.
Kansas City
III
IX
ARIZ.
N.M.
OKLA.
KY.
VA.
TENN.
N.C.
ARK.
S.C.
MISS.
ALA.
GA.
Atlanta
VI
Dallas/Ft. Worth
IV
LA.
TEX.
FLA.
Reg. X
ALASKA
Reg. IX
HAWAII
GUAM
Reg. II
VIRGIN ISLANDS
PUERTO RICO

TERMINOLOGY

ACT (American College Testing) and SAT (Scholastic Aptitude Test) - Standardized examinations which are intended to provide applicants and institutions with a numerical statement of an individual's ability and readiness to successfully complete college/university level work.

Co-op program - A plan whereby a student receives financial assistance and academic credit under the direction of a cooperating employment site representative and a faculty advisor in exchange for an agreed upon condition of employment. Students must complete all degree requirements as per the norm.

Course - For the purpose of this study, a course is considered a unit of a program, in which a body of knowledge is presented, the satisfactory completion of which leads to the awarding of a predetermined or individually arranged number of credits.

ECPD (Engineers' Council for Professional Development) - Accrediting body for programs in engineering technology.

ERIC (Educational Resources Information Center) - A national information system designed and developed by the U.S. Office of Education, and now supported and operated by the National Institute of Education (NIE), for providing ready access to descriptions of exemplary programs, research and development efforts, and related information that can be used in developing more effective educational programs.

GRE (Graduate Record Examination) - (General Aptitude) An examination of verbal and mathematical competency and aptitude, which is designed to provide a numerical indication of an individual's ability to successfully complete advanced level work. For the purposes of the study, the GRE will not refer to the Advanced Examinations.

Internship/Applied Study Term - An arrangement which is intended to provide a simulation of work experience under the direction of academic advisors and is designed to be an integral segment of an individual's academic program. (College credit may be given.)

IRIS (Instructional Resources Information System) - A computerized information base listing materials relating to education and training in the water quality control field, which is located in the National Training and Operational Technology Center of the U.S. Environmental Protection Agency.

MEDLINE - Computerized literature search services with application to medical information.

NTIS (National Technical Information Service) - Computerized literature search services.

Program - For the purpose of this study, a plan of study, either completely prescribed, or containing options, with an identity of its own, and standard rules and procedures, the satisfaction of which may lead to a degree, certificate, or diploma.

Quarter hours - vs. - Semester hours - One semester hour is the credit equivalent to one and a half quarter hours.

Standard Federal Boundaries - Geographic division of the United States for the purposes of decentralized administration; in this report also referred to as EPA regions (see map on preceding page).

TOXLINE - Computerized literature search services with particular application to the recall of information concerning toxic substances.

WRSIC (Water Resources Scientific Information Center) - Collects, screens, organizes and disseminates reports in water resources.

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APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
AIR	Carnegie-Mellon University	Pittsburgh, PA
	Clemson University	Clemson, SC
	Drexel University	Philadelphia, PA
	George Washington University-NASA	Hampton, VA
	Harvard University School of Public Health	Boston, MA
	Hudson Valley Community College	Troy, NY
	Massachusetts Institute of Technology	Ithaca, NY
	Michigan Technological University	Houghton, MI
	Middlesex County College	Edison, NJ
	Muskingum Area Technical College	Zanesville, OH
	New Jersey Institute of Technology	Newark, NJ
	North Carolina State University	Chapel Hill, NC
	North Dakota State School of Science	Wahpeton, ND
	Northeastern University	Boston, MA
	Ohio State University	Columbus, OH
	Portland State University	Portland, OR
	Prairie State Community College	Chicago Heights, IL
	Purdue University	West Layfayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rutgers-The State University of New Jersey	New Brunswick, NJ
	Springfield Technical Community College	Springfield, MA
	Stevens Institute of Technology	Hoboken, NJ
	Sumter University	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	The Pennsylvania State University	University Park, PA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Florida	Gainesville, FL
	University of Iowa	Iowa City, IA
	University of Kentucky	Lexington, KY
	University of Maryland	College Park, MD
	University of Michigan	Ann Arbor, MI
	University of Missouri-Rolla	Rolla, MO
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Texas-Austin	Austin, TX
	University of Washington	Seattle, WA
	University of Wisconsin-Milwaukee	Milwaukee, WI
	Vanderbilt University	Nashville, TN
	Washington State University	Pullman, WA
	Washington University	St. Louis, MO
	West Virginia University	Morgantown, WV
	Yale University	New Haven, CT

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE:	Antioch College	Yellow Springs, OH
	Baylor University	Waco, TX
	Bemidji State University	Bemidji, MN
	California Institute of Technology	Pasadena, CA
	California Polytechnic State University	San Luis Obispo, CA
	Catholic University of America	Washington, DC
	Carnegie-Mellon University	Pittsburgh, PA
	Chattanooga State Technical Community College	Chattanooga, TN
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Cornell University	Ithaca, NY
	Delaware Technical and Community College	Newark, DE
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	Duke University	Durham, NC
	East Central Oklahoma State University	Ada, OK
	East Tennessee State University	Johnson City, TN
	Evergreen State College	Olympia, WA
	Ferris State College	Big Rapids, MI
	Florida International University	Miami, FL
	Georgia Institute of Technology	Atlanta, GA
	Heed University	Hollywood, FL
	Hocking Technical College	Nelsonville, OH
	Howard University	Washington, DC
	Hunter College	New York, NY
	Indiana University	Bloomington, IN
	Iowa State University	Ames, IA
	Johns Hopkins University	Baltimore, MD
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Lamar University	Beaumont, TX
	Macalester College	St. Paul, MN
	Massachusetts Institute of Technology	Cambridge, MA
	McNeese State University	Lake Charles, LA
	Miami University	Oxford, OH
	Michigan State University	East Lansing, MI
	Middle Tennessee State University	Murfreesboro, TN
	Morehead State University	Morehead, KY
	Muskingum Area Technical College	Zanesville, OH
	New Jersey Institute of Technology	Newark, NJ
	North Carolina State University	Raleigh, NC
	Northland College	Ashland, WI
	Ohio State University	Columbus, OH

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
OMPOSITE: Cont'd)	Ohio University	Athens, OH
	Oscar Rose Junior College	Midwest City, OK
	OSU Oklahoma City Technical Institute	Oklahoma City, OK
	Polytechnical Institute of New York	Brooklyn, NY
	Princeton University	Princeton, NJ
	Purdue University	West Lafayette, IN
	Raymond Walters General and Technical College (University of Cincinnati	Cincinnati, OH
	Rensselaer Polytechnical Institute	Troy, NY
	Rutgers University	New Brunswick, NJ
	Sam Houston State University	Huntsville, TX
	Sangamon State University	Springfield, IL
	Slippery Rock State College	Slippery Rock, PA
	Springfield Technical and Community College	Springfield, MA
	Stevens Institute of Technology	Hoboken, NJ
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas A & M University	College Station, TX
	The Cooper Union	New York, NY
	The Pennsylvania State University	University Park, PA
	University of Alabama	University, AL
	University of Alaska	Fairbanks, AK
	University of Arkansas	Fayetteville, AR
	University of California-Santa Barbara	Santa Barbara, CA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Florida	Gainesville, FL
	University of Georgia	Athens, GA
	University of Kansas	Lawrence, KS
	University of Louisville	Louisville, KY
	University of Maine-Orono	Orono, Maine
	University of Michigan	Ann Arbor, MI
	University of Minnesota	Minneapolis, MN
	University of North Carolina	Chapel Hill, NC
	University of Oklahoma	Norman, OK
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Toledo	Toledo, OH
	University of Utah	Salt Lake City, UT
	University of Washington	Seattle, WA
	University of Wisconsin-Green Bay	Green Bay, WI
	University of Wisconsin-Madison	Madison, WI
	Utah State University	Logan, UT

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE: (Cont'd)	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Washington State University	Pullman, WA
	Western Kentucky University	Bowling Green, KY
	Western Washington University (Huxley College of Environmental Studies)	Bellingham, WA
	West Virginia University	Morgantown, WV
	Yale University	New Haven, CT
ENERGY:	Bluefield State College	Bluefield, WV
	Brigham Young University	Provo, UT
	Carnegie-Mellon University	Pittsburgh, PA
	Columbia University	New York, NY
	Cornell University	New York, NY
	Georgia Institute of Technology	Atlanta, GA
	Hartford State Technical College	Hartford, CT
	Kansas State University	Manhattan, KS
	Lamar University	Beaumont, TX
	Massachusetts Institute of Technology	Cambridge, MA
	Morehead State University	Morehead, KY
	Muskingum Area Technical College	Zanesville, OH
	Oregon State University	Corvallis, OR
	Pikeville College	Pikeville, KY
	Polytechnic Institute of New York	Brooklyn, NY
	Princeton University	Princeton, NJ
	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Southern Technical Institute	Marietta, GA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Kentucky	Lexington, KY
	University of New Mexico	Albuquerque, NM
	University of Pennsylvania	Philadelphia, PA
	University of Tennessee	Knoxville, TN
	West Virginia Institute of Technology	Montgomery, WV
	West Virginia University	Morgantown, WV

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
OISE:	George Washington University-NASA	Hampton, VA
	Georgia Institute of Technology	Altanta, GA
	Massachusetts Institute of Technology	Cambridge, MA
	Memphis State University	Memphis, TN
	North Carolina State University	Raleigh, NC
	The Pennsylvania State University	University Park, PA
	University of Cincinnati	Cincinnati, OH
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Tennessee Center for Health Sciences	Memphis, TN
ESTICIDES:	Abraham Baldwin Agricultural College	Tifton, GA
	Broward Community College	Ft. Lauderdale, FL
	Central Technical Community College	Hastings, NE
	Delgado Community College	New Orleans, LA
	Harvard University School of Public Health	Boston, MA
	Mississippi State University	Mississippi State, MS
	New Mexico State University	Las Cruces, NM
	North Carolina State University	Raleigh, NC
	Ohio State University	Columbus, OH
	Oregon State University	Corvallis, OR
	Rutgers State University of New Jersey	New Brunswick, NJ
	State University of New York at Farmingdale	Farmingdale, NY
	Texas A & M University	College Station, TX
	The Pennsylvania State University	University Park, PA
	University of California-Berkeley	Berkeley, CA
	University of California-Davis	Davis, CA
	University of California-Riverside	Riverside, CA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Georgia	Athens, GA
	University of Iowa	Iowa City, IA
	University of Maryland	College Park, MD
	University of New Hampshire	Durham, NH
	University of Pittsburgh	Pittsburgh, PA
	University of Rochester	Rochester, NY
	Utah State University	Logan, UT

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
POTABLE WATER:	Atlanta University Center/Georgia Institute of Technology	Atlanta, GA
	Brigham Young University	Provo, UT
	California State University	Sacramento, CA
	Carnegie-Mellon University	Pittsburgh, PA
	Casper College	Casper, WY
	Central Technical Community College	Hastings, NE
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Colorado State University	Fort Collins, CO
	Community College of Denver-Red Rocks	Golden, CO
	Cornell University	Ithaca, NY
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	East Maine Vocational Technical Institute	Bangor, ME
	Hudson Valley Community College	Troy, NY
	Illinois Institute of Technology	Chicago, IL
	Iowa State University	Ames, IA
	J. Sargeant Reynolds Community College	Richmond, VA
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Linn-Benton Community College	Albany, OR
	Manhattan College	New York, NY
	Marquette University	Milwaukee, WI
	Massachusetts Institute of Technology	Cambridge, MA
	Miami-Dade Community College	Miami, FL
	Michigan Technological University	Houghton, MI
	Middlesex Community College	Edison, NJ
	Missouri Southern State College	Joplin, MO
	Montana State University	Bozeman, MT
	Muskingum Area Technical College	Zanesville, OH
	Northeastern University	Boston, MA
	Northern Montana College	Havre, MT
	Ohio State University	Columbus, OH
	Operator Training Center	Murfreesboro, TN
	Oregon Institute of Technology	Klamath Falls, OR
	Oscar Rose Junior College	Midwest City, OK
	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rice University	Houston, TX
	Rochester Institute of Technology	Rochester, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	Southern Illinois University	Edwardsville, IL

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
OTABLE WATER: Cont'd)	Springfield Technical Community College	Springfield, MA
	Stanford University	Stanford, CA
	State University of New York at Buffalo	Buffalo, NY
	Stevens Institute of Technology	Hoboken, NJ
	Sumter Technical Community College	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	The Pennsylvania State University/ Capitol Campus	Middletown, PA
	Tufts University	Boston, MA
	Ulster County Community College	Stone Ridge, NY
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Hawaii	Honolulu, HI
	University of Iowa	Iowa City, IA
	University of Kansas	Lawrence, KS
	University of Kentucky	Lexington, KY
	University of Maine at Orono	Orono, ME
	University of Michigan	Ann Arbor, MI
	University of Missouri-Columbia	Columbia, MO
	University of Missouri-Rolla	Rolla, MO
	University of Nebraska	Lincoln, NE
	University of North Carolina	Chapel Hill, NC
	University of Pennsylvania	Philadelphia, PA
	University of Pittsburgh	Pittsburgh, PA
	University of Rhode Island	Kingston, RI
	University of Tennessee	Knoxville, TN
	University of Texas-Austin	Austin, TX
	University of Wisconsin-Madison	Madison, WI
	University of Wyoming	Laramie, WY
	Utah State University	Logan, UT
	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Water and Wastewater Technical School	Neosho, MO
	West Georgia College	Carrollton, GA
	West Virginia University	Morgantown, WV
	Wytheville Community College	Wytheville, VA

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
RADIATION:	Central Florida Community College	Ocala, FL
	Chattanooga State Technical Community College	Chattanooga, TN
	Columbia University	New York, NY
	Cornell University	Ithaca, NY
	Hartford State Technical College	Hartford, CT
	Harvard University School of Public Health	Boston, MA
	Kansas State University	Manhattan, KS
	Massachusetts Institute of Technology	Cambridge, MA
	Memphis State University	Memphis, TN
	Missouri Southern State College	Joplin, MO
	Oak Ridge Associated Universities	Oak Ridge, TN
	Oklahoma State University	Stillwater, OK
	Rensselaer Polytechnic Institute	Troy, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	St. Louis Community College at Forest Park	St. Louis, MO
	Southern Technical Institute	Marietta, GA
	The Pennsylvania State University	University Park, PA
	University of Florida	Gainesville, FL
	University of Kansas	Lawrence, KS
	University of Lowell	Lowell, MA
	University of Maryland	College Park, MD
	University of Michigan	Ann Arbor, MI
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
SOLID WASTE:	Carnegie-Mellon University	Pittsburgh, PA
	Clarkson College	Potsdam, NY
	Cornell University	New York, NY
	Drexel University	Philadelphia, PA
	Hofstra University	Hempstead, NY
	Michigan Technological University	Houghton, MI
	Rensselaer Polytechnic Institute	Troy, NY
	Temple University	Philadelphia, PA
	The Pennsylvania State University	University Park, PA
	University of Iowa	Iowa City, IA
	University of Missouri-Rolla	Rolla, MO
	University of Pittsburgh	Pittsburgh, PA
	Vanderbilt University	Nashville, TN
	West Virginia University	Morgantown, WV
	Wilson County Technical Institute	Wilson, NC
	Yale University	New Haven, CT

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
ASTEWATER:	Atlanta University Center/ Georgia Institute of Technology	Atlanta, GA
	Brigham Young University	Provo, UT
	California State University-Sacramento	Sacramento, CA
	Carnegie-Mellon University	Pittsburgh, PA
	Casper College	Casper, WY
	Central Technical Community College	Hastings, NE
	Charles County Community College	La Plata, MD
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Colorado State University	Fort Collins, CO
	Community College of Denver-Red Rocks	Golden, CO
	Cornell University	Ithaca, NY
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	East Maine Vocational Technical Institute	Bangor, ME
	Greenville Technical College	Greenville, SC
	Harvard University	Cambridge, MA
	Hudson Valley Community College	Troy, NY
	Illinois Institute of Technology	Chicago, IL
	Iowa State University	Ames, IA
	J. Sargeant Reynolds Community College	Richmond, VA
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Linn-Benton Community College	Albany, OR
	Manhattan College	New York, NY
	Marquette Technical University	Milwaukee, WI
	Massachusetts Institute of Technology	Cambridge, MA
	Miami-Dade Community College	Miami, FL
	Michigan Technological University	Houghton, MI
	Middlesex County College	Edison, NJ
	Missouri Southern State College	Joplin, MO
	Montana State University	Bozeman, MT
	Muskingum Area Technical College	Zanesville, OH
	New England Regional Wastewater Institute	S. Portland, ME
	New Jersey Institute of Technology	Newark, NJ
	Northeastern University	Boston, MA
	Northern Montana College	Havre, MT
	Ohio State University	Columbus, OH
	Operator Training Center	Murfreesboro, TN
	Oregon Institute of Technology	Klamath Falls, OR
	Oscar Rose Junior College	Midwest City, OK

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
WASTEWATER: (Cont'd)	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rice University	Houston, TX
	Rochester University	Rochester, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	Southern Illinois University	Edwardsville, IL
	Springfield Technical and Community College	Springfield, MA
	Stanford University	Stanford, CA
	State Technical Institute at Memphis	Memphis, TN
	State University of New York-Buffalo	Buffalo, NY
	Stevens Institute of Technology	Hoboken, NJ
	Sumter Technical Community College	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	The Pennsylvania State University/ Capitol Campus	Middletown, PA
	Tufts University	Boston, MA
	Ulster County Community College	Stone Ridge, NY
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Hawaii	Honolulu HI
	University of Kansas	Lawrence, KS
	University of Kentucky	Lexington, KY
	University of Lowell	Lowell, MA
	University of Maine at Orono	Orono, ME
	University of Missouri-Columbia	Columbia, MO
	University of Missouri-Rolla	Rolla, MO
	University of Nebraska	Lincoln, NE
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Rhode Island	Kingston, RI
	University of Tennessee	Knoxville, TN
	University of Texas	Austin, TX
	University of Wisconsin-Madison	Madison, WI
	University of Wyoming	Laramie, WY
	Utah State University	Logan, UT
	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Water and Wastewater Technical School	Neosho, MO
	West Georgia College	Carrollton, GA
	West Virginia University	Morgantown, WV
	Wytheville Community College	Wytheville, VA

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
AL	Alabama A & M University	Huntsville
	Alabama Christian College	Montgomery
	Alabama Lutheran Junior College	Selma
	Alexander City State Junior College	Alexander City
	Athens State College	Athens
	Auburn University	Auburn
	Auburn University at Montgomery	Montgomery
	Birmingham-Southern College	Birmingham
	Brewer State Junior College	Fayette
	Enterprise State Junior College	Enterprise
	Faulkner State Junior College	Bay Minette
	Gadsden State Junior College	Gadsden
	George C. Wallace State Community College	Dothan
	George C. Wallace State Community College	Selma
	Jacksonville State University	Jacksonville
	Jefferson Davis State Junior College	Brewton
	Jefferson State Junior College	Birmingham
	John C. Calhoun State Community College	Decatur
	Judson College	Marion
	Livingston University	Livingston
	Lawson State Community College	Birmingham
	Lurleen B. Wallace State Junior College	Andalusia
	Marion Military Institute	Marion
	Miles College	Birmingham
	Mobile College	Mobile
	Northeast Alabama State Junior College	Rainsville
	Northwest Alabama State Junior College	Phil Campbell
	Oakwood College	Huntsville
	Samford University	Birmingham
	Selma University	Selma
	Snead State Junior College	Boaz
	Southeastern Bible College	Birmingham
	Southern Benedictine College	Saint Bernard
	Southern Union State Junior College	Wadley
	Spring Hill College	Mobile
	Stillman College	Tuscaloosa
	Talladega College	Talladega
	Troy State University	Troy
	Tuskegee Institute	Tuskegee Institute
	University of Alabama	University
	University of Alabama in Birmingham	Birmingham
	University of Alabama in Huntsville	Huntsville
	University of Montevallo	Montevallo
	University of North Alabama	Florence
	University of South Alabama	Mobile
	Walker College	Jasper
AK	Sheldon Jackson College	Sitka
	University of Alaska-Fairbanks	Fairbanks
	University of Alaska Juneau Senior College	Juneau
AS	American Samoa Community College	Pago Pago
AZ	American Graduate School of International Management	Glendale
	Arizona State University	Tempe
	Arizona Western College	Yuma

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Central Arizona College	Coolidge
	Cochise College	Douglas
	College of Ganado	Ganado
	DeVry Institute of Technology	Phoenix
	Eastern Arizona College	Thatcher
	Grand Canyon College	Phoenix
	Maricopa County Community College System Office	Phoenix
	Glendale Community College	Glendale
	Maricopa Technical Community College	Phoenix
	Mesa Community College	Mesa
	Phoenix College	Phoenix
	Scottsdale Community College	Scottsdale
	Mohave Community College	Kingman
	Navajo Community College	Tsaile
	Northern Arizona University	Flagstaff
	Northland Pioneer College	Holbrook
	Pima Community College	Tucson
	Southwestern College	Phoenix
	University of Arizona	Tucson
	Yavapai College	Prescott
AR	Arkansas College	Batesville
	Arkansas State University-Main Campus	State University
	Arkansas State University-Beebe Branch	Beebe
	Arkansas Tech University	Russellville
	Central Baptist College	Conway
	College of the Ozarks	Clarksville
	Crowley's Ridge College	Paragould
	Garland County Community College	Hot Springs
	Harding College-Main Campus	Searcy
	Henderson State University	Arkadelphia
	Hendrix College	Conway
	John Brown University	Siloam Springs
	Mississippi County Community College	Blytheville
	Quachita Baptist University	Arkadelphia
	Philander Smith College	Little Rock
	Phillips County Community College	Helena
	Southern Arkansas University	Magnolia
	Southern Arkansas University Southwest Technical Institute	East Camden
	Southern Baptist College	Walnut Ridge
	Southern State College	Magnolia
	University of Arkansas-Main Campus	Fayetteville
	University of Arkansas-Little Rock	Little Rock
	University of Arkansas Medical Sciences Campus	Little Rock
	University of Arkansas-Monticello	Monticello
	Westlark Community College	Fort Smith
CA	Allan Hancock College	Santa Maria
	Ambassador College	Pasadena
	American Baptist Seminary of the West-Central Office	Berkeley
	American Baptist Seminary of the West-Covina	Covina
	Armstrong College	Berkeley
	Azusa Pacific College	Azusa
	Bakersfield College	Bakersfield
	Barstow College	Barstow
	Bauder College	Sacramento
	Bethany Bible College	Santa Cruz
	Biola College	La Mirada
	Brooks College	Long Beach

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Brooks Institute of Santa Barbara	Santa Barbara
	Butte College	Oroville
	Cabrillo College	Aptos
	California Baptist College	Riverside
	California College of Arts and Crafts	Oakland
	California Institute of the Arts	Valencia
	California Institute of Asian Studies	San Francisco
	California Institute of Technology	Pasadena
	California Lutheran College	Thousand Oaks
	California Maritime Academy	Vallejo
	California State College-San Bernadino	San Bernardino
	California State College-Stanislaus	Turlock
	California Polytechnic State University-San Luis Obispo	San Luis Obispo
	California State University-Fresno	Fresno
	California State University-Fullerton	Fullerton
	California State University-Hayward	Hayward
	California State University-Long Beach	Long Beach
	California State University-Los Angeles	Los Angeles
	California State University-Sacramento	Sacramento
	San Diego State University	San Diego
	San Jose State University	San Jose
	Cerritos College	Norwalk
	Cerro Coso Community College	Ridgecrest
	Chapman College	Orange
	Christian Heritage College	El Cajon
	Church Divinity School of the Pacific	Berkeley
	Citrus College	Azusa
	Claremont Colleges-System Office	Claremont
	Claremont Men's College	Claremont
	Claremont University Center and Graduate School	Claremont
	Harvey Mudd College	Claremont
	Pitzer College	Claremont
	Pomona College	Claremont
	Scripps College	Claremont
	Coast Community College-System Office	Costa Mesa
	Golden West College	Huntington Beach
	Orange Coast College	Costa Mesa
	Cogswell College	San Francisco
	Colegio De La Tierra	Goshen
	College of the Canyons	Valencia
	College of the Desert	Palm Desert
	College of Marin	Kentfield
	College of Notre Dame	Belmont
	College of the Redwoods	Eureka
	College of the Siskiyous	Weed
	Columbia Junior College	Columbia
	Compton Community College	Compton
	Contra Costa Community College-System Office	
	Diablo Valley College	Pleasant Hill
	Cuesta College	San Luis Obispo
	Cypress College	Cypress
	Dominican College of San Rafael	San Rafael
	El Camino College	Torrance
	Foothill-De Anza Community Colleges	
	District-System Office	Los Altos Hills
	De Anza College	Cupertino
	Foothill College	Los Altos Hills
	Fuller Theological Seminary	Pasadena
	Gavilan College	Gilroy
	Glendale Community College	Glendale
	Golden Gate University	San Francisco
	Grossmont College	El Cajon
	Hartnell College	Salinas
	Holy Family College	Mission San Jose

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Holy Names College	Oakland
	Immaculate Heart College	Los Angeles
	Indian Valley Colleges	Novato
	John F. Kennedy University	Orinda
	Lake Tahoe Community College	S. Lake Tahoe
	Lassen College	Susanville
	LaVerne College	La Verne
	L.I.F.E. Bible College	Los Angeles
	Lincoln University	San Francisco
	Lone Mountain College	San Francisco
	Long Beach City College	Long Beach
	Los Angeles Baptist College	Newhall
	Los Angeles Community College-System Office	Los Angeles
	East Los Angeles College	Los Angeles
	Los Angeles City College	Los Angeles
	Los Angeles Harbor College	Wilmington
	Los Angeles Mission College	San Fernando
	Los Angeles Pierce College	Woodland Hills
	Los Angeles Southwest College	Los Angeles
	Los Angeles Valley College	Van Nuys
	West Los Angeles College	Culver City
	Los Rios Community College-System Office	Sacramento
	Cosumnes River College	Sacramento
	Sacramento City College	Sacramento
	Loyla Marymount University	Los Angeles
	Marymount Palos Verdes College	Rancho Palos Verdes
	Mendocino College	Ukiah
	Menlo College	Menlo Park
	Mennonite Brethren Biblical Seminary	Fresno
	Merced College	Merced
	Mills College	Oakland
	Monterey Institute for Foreign Studies	Monterey
	Monterey Peninsula College	Monterey
	Mount San Antonio College	Walnut
	Mount San Jacinto College	San Jacinto
	Napa College	Napa
	National University	San Diego
	New College of California	San Francisco
	Northrop University	Inglewood
	Occidental College	Los Angeles
	Ohlone College	Fremont
	Otis Art Institute of Los Angeles County	Los Angeles
	Pacific Christian College	Fullerton
	Pacific College	Fresno
	Pacific Oaks College	Pasadena
	Pacific School of Religion	Berkeley
	Pacific Union College	Angwin
	Palomar College	San Marcos
	Palo Verde College	Blythe
	Pasadena City College	Pasadena
	Patten Bible College	Oakland
	Pepperdine University	Malibu
	Peralta Community Colleges-System Office	Oakland
	College of Alameda	Alameda
	Point Loma College	San Diego
	Porterville College	Porterville
	Rand Graduate Institute of Policy Studies	Santa Monica
	Riverside City College	Riverside
	Rosemead Graduate School of Psychology	Rosemead
	Saddleback Community College	Mission Viejo
	Saint Mary's College of California	Moraga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Saint Patrick's College	Mountain View
	San Diego Community College-Central Office	San Diego
	San Diego Community College-City College	San Diego
	San Diego Community College-Evening College	
	San Francisco Art Institute	San Francisco
	San Francisco Conservatory of Music	San Francisco
	San Francisco Theological Seminary	San Anselmo
	San Joaquin Delta College	Stockton
	San Jose Community College District-	
	Evergreen Valley College	San Jose
	San Jose City College	San Jose
	San Mateo County Community College District-System Office	San Mateo
	Canada College	Redwood City
	College of San Mateo	San Mateo
	Skyline College	San Bruno
	Santa Ana College	Santa Ana
	Santa Barbara City College	Santa Barbara
	Santa Monica College	Santa Monica
	Santa Rosa Junior College	Santa Rosa
	Shasta College	Redding
	Sierra College	Rocklin
	Simpson College	San Francisco
	Solano Community College	Suisun City
	Southern California College	Costa Mesa
	Southern California College of Optometry	Fullerton
	Southwestern University School of Law	Los Angeles
	Stanford University	Stanford
	State Center Community College District	
	Fresno City College	Fresno
	Reedley College	Reedley
	Taft College	Taft
	United States International University	San Diego
	University of California-Berkeley	Berkeley
	University of California-Davis	Davis
	University of California Hastings College of Law	San Francisco
	University of California-Irvine	Irvine
	University of California-Los Angeles	Los Angeles
	University of California-Riverside	Riverside
	University of California-San Francisco	San Francisco
	University of California-Santa Barbara	Santa Barbara
	University of the Pacific	Stockton
	University of Redlands	Redlands
	University of San Diego	San Diego
	University of San Francisco	San Francisco
	University of Santa Clara	Santa Clara
	University of Southern California	Los Angeles
	University of West Los Angeles	Culver City
	Ventura County Community College District	
	Moorpark College	Moorpark
	Oxnard College	Oxnard
	Ventura College	Ventura
	West Coast Bible College	Fresno
	West Coast University Central Office	Los Angeles
	West Coast University Orange County Center	Orange
	Western State University College of Law-Orange County	Fullerton
	Western State University College of Law-San Diego	San Diego
	West Hills College	Coalinga
	Westmont College	Santa Barbara
	West Valley College	Saratoga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Whittier College	Whittier
	Woodbury University	Los Angeles
	The Wright Institute	Berkeley
	Yuba College	Marysville
CO	Adams State College	Alamosa
	Aims Community College	Greeley
	Arapahoe Community College	Littleton
	Colorado College	Colorado Springs
	Colorado Mountain College-East Campus	Leadville
	Colorado Mountain College-West Campus	Glenwood Springs
	Colorado School of Mines	Golden
	Colorado State University	Fort Collins
	Colorado Technical College	Manitou Springs
	Colorado Women's College	Denver
	Community College of Denver-Auraria Campus	Denver
	Community College of Denver-North Campus	Denver
	Community College of Denver-Red Rocks Campus	Golden
	Conservative Baptist Theological Seminary	Denver
	El Paso Community College	Colorado Springs
	Fort Lewis College	Durango
	Iliff School of Theology	Denver
	Lamar Community College	Lamar
	Loretto Heights College	Denver
	Mesa College	Grand Junction
	Metropolitan State College	Denver
	Morgan Community College	Fort Morgan
	Northeastern Junior College	Sterling
	Ortero Junior College	La Junta
	Regis College	Denver
	Rockmont College	Denver
	Saint Thomas Seminary	Denver
	Trinidad State Junior College	Trinidad
	University of Colorado-Boulder	Boulder
	University of Colorado-Colorado Springs	Colorado Springs
	University of Colorado-Denver	Denver
	University of Denver	Denver
	University of Denver College of Law	Denver
	University of Northern Colorado	Greeley
	University of Southern Colorado	Pueblo
	Western Bible College	Morrison
	Western State College of Colorado	Gunnison
CT	Albertus Magnus College	New Haven
	Annhurst College	Woodstock
	Bridgeport Engineering Institute	Bridgeport
	Connecticut College	New London
	Eastern Connecticut State College	Willimantic
	Greater Hartford Community College	Hartford
	Hartford State Technical College	Hartford
	Housatonic Regional Community College	Bridgeport
	Mattatuck Community College	Waterbury
	Middlesex Community College	Middletown
	Mitchell College	New London
	Mohegan Community College	Norwich
	Northwestern Connecticut Community College	Winsted
	Norwalk Community College	Norwalk
	Post Junior College	Waterbury
	Quinebaug Valley Community College	Danielson
	Saint Joseph College	West Hartford

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Thames Valley State Technical College	Norwich
	Trinity College	Hartford
	Tunxis Community College	Farmington
	University of Bridgeport	Bridgeport
	University of Hartford	West Hartford
	University of New Haven	West Haven
	Yale University	New Haven
DE	Delaware State College	Dover
	Delaware Technical and Community College	Dover
	Goldey Beacom College	Wilmington
	University of Delaware	Newark
	Wesley College	Dover
DC	American University	Washington
	Catholic University of America	Washington
	District of Columbia Teachers College	Washington
	Gallaudet College	Washington
	George Washington University	Washington
	Howard University	Washington
	Mount Vernon College	Washington
	Trinity College	Washington
FL	Barry College	Miami
	Brevard Community College	Cocoa
	Broward Community College	Fort Lauderdale
	Central Florida Community College	Ocala
	Chipola Junior College	Marianna
	College of Boca Raton	Boca Raton
	Daytona Beach Community College	Daytona Beach
	Eckerd College	St. Petersburg
	Edison Community College	Fort Meyers
	Embry-Riddle Aeronautical University	Daytona Beach
	Flagler College	St. Augustine
	Florida A & M University	Tallahassee
	Florida Atlantic University	Boca Raton
	Florida College	Temple Terrace
	Florida International University	Miami
	Florida Junior College	Jacksonville
	Florida Keys Community College	Key West
	Florida Southern College	Lakeland
	Florida Technological University	Orlando
	Fort Lauderdale College	Fort Lauderdale
	Gulf Coast Community College	Panama City
	Hood University	Hollywood
	Hillsborough Community College	Tampa
	Indian River Community College	Fort Pierce
	Jacksonville University	Jacksonville
	Jones College	Jacksonville
	Lake City Community College	Lake City
	Lake-Sumter Community College	Leesburg
	Manatee Junior College	Bradenton
	Miami Christian College	Miami
	Miami-Dade Community College	Miami
	North Florida Junior College	Madison
	Nova University	Fort Lauderdale
	Okaloosa-Walton Junior College	Niceville
	Palm Beach Atlantic College	West Palm Beach
	Palm Beach Junior College	Lake Worth
	Pensacola Junior College	Pensacola
	Polk Community College	Winter Haven

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Rollins College	Winter Park
	Saint Johns River Junior College	Palatka
	Saint Leo College	Saint Leo
	Santa Fe Community College	Gainesville
	Seminole Community College	Sanford
	South-Eastern Bible College	Lakeland
	South Florida Junior College	Avon Park
	University of Florida	Gainesville
	University of Miami	Coral Gables
	University of North Florida	Jacksonville
	Warner Southern College	Lake Wales
	Webber College	Babson Park
GA	Abraham Baldwin Agricultural College	Tifton
	Agnes Scott College	Decatur
	Albany Area Vocational Technical School	Albany
	Albany Junior College	Albany
	Albany State College	Albany
	Andrew College	Cuthbert
	Armstrong State College	Savannah
	Atlanta Christian College	East Point
	Atlanta Junior College	Atlanta
	Atlanta University	Atlanta
	Augusta College	Augusta
	Bainbridge Junior College	Bainbridge
	Berry College	Mount Berry
	Brenau College	Gainesville
	Brewton-Parker College	Mount Vernon
	Carroll County Area Vocational-Technical School	Carrollton
	Carver Bible Institute and College	Atlanta
	Clark College	Atlanta
	Clayton Junior College	Morrow
	Columbus College	Columbus
	Dalton Junior College	Dalton
	DeKalb Community College	Clarkston
	Emanuel County Junior College	Swainsboro
	Emory University	Atlanta
	Fort Valley State College	Fort Valley
	Gainesville Junior College	Gainesville
	Georgia College	Milledgeville
	Georgia Institute of Technology	Atlanta
	Georgia Military College	Milledgeville
	Georgia Southern College	Statesboro
	Georgia Southwestern College	Americus
	Georgia State University	Atlanta
	Gordon Junior College	Barnesville
	Kennesaw Junior College	Marietta
	LaGrange College	LaGrange
	Macon Junior College	Macon
	Marietta-Cobb Area Vocational Technical School	Marietta
	Mercer University	Macon
	Mercer University in Atlanta	Atlanta
	Middle Georgia College	Cochran
	Morehouse College	Atlanta
	Moultrie Area Vocational-Technical School	Moultrie
	North Georgia College	Dahlonega
	North Georgia Technical and Vocational School	Clarkesville
	Oglethorpe College	Atlanta
	Pickens Area Vocational-Technical School	Jasper
	Piedmont College	Demorest
	Reinhardt College	Waleska

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Savannah Area Vocational Technical School	Savannah
	Savannah State College	Savannah
	Shorter College	Rome
	South Georgia College	Douglas
	South Georgia Technical and Vocational School	Americus
	Southern Technical Institute	Marietta
	Swainsboro Area Vocational-Technical School	Swainsboro
	Thomas Area Vocational-Technical School	Thomasville
	Tift College	Forsyth
	Toccoa Falls College	Toccoa Falls
	Troup County Area Vocational Technical School	LaGrange
	Truett McConnell College	Cleveland
	University of Georgia	Athens
	Upson County Area Vocational-Technical School	Thomaston
	Valdosta State College	Valdosta
	Valdosta Technical School	Valdosta
	Walker County Area Technical School	Rock Spring
	Waycross-Ware Area Technical School	Waycross
	Wesleyan College	Macon
	West Georgia College	Carrollton
	Young Harris College	Young Harris
HI	Brigham Young University-Hawaii Campus	Laie Oahu
	Chaminade College of Honolulu	Honolulu
	Hawaii Pacific College	Honolulu
	University of Hawaii-Honolulu Community College	Honolulu
	University of Hawaii-Kapiolani Community College	Honolulu
	University of Hawaii-Kauai Community College	Lihue
	University of Hawaii-Leeward Community College	Pearl City
	University of Hawaii-Manoa	Honolulu
	University of Hawaii-Maui Community College	Kahului
	University of Hawaii-Windward Community College	Kaneohe
ID	Boise State University	Boise
	College of Southern Idaho	Twin Falls
	Idaho State University	Pocatello
	North Idaho College	Coeur D'Alene
	Northwest Nazarene College	Nampa
	Ricks College	Rexburg
	University of Idaho	Moscow
IL	Augustana College	Rock Island
	Aurora College	Aurora
	Barat College	Lake Forest
	Belleville Area College	Belleville
	Blackburn College	Carlinville
	Black Hawk College	Moline
	Bradley University	Peoria
	Carl Sandburg College	Galesburg
	Central YMCA Community College	Chicago
	Chicago College of Osteopathic Medicine	Chicago
	Chicago State University	Chicago
	College of DuPage	Glen Ellyn

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	College of Lake County	Grayslake
	College of St. Francis	Joliet
	College of the University of Chicago	Chicago
	Danville Junior College	Danville
	DeLourdes College	Des Plaines
	DePaul University	Chicago
	DeVry Institute of Technology	Chicago
	Eastern Illinois University	Charleston
	Elgin Community College	Elgin
	Elmhurst College	Elmhurst
	Eureka College	Eureka
	George Williams College	Downers Grove
	Governors State University	Park Forest South
	Greenville College	Greenville
	Highland Community College	Freeport
	Illinois Benedictine College	Lisle
	Illinois Central College	East Peoria
	Illinois College	Jacksonville
	Illinois College of Optometry	Chicago
	Illinois College of Podiatric Medicine	Chicago
	Illinois Institute of Technology	Chicago
	Illinois State University	Normal
	Illinois Valley Community College	Oglesby
	Illinois Wesleyan University	Bloomington
	Joliet Junior College	Joliet
	Judson College	Elgin
	Kankakee Community College	Kankakee
	Kendall College	Evanston
	Kishwaukee College	Malta
	Knox College	Galesburg
	Lake Forest College	Evanston
	Lakeland College	Mattoon
	Lewis and Clark Community College	Godfrey
	Lincoln Trail College	Robinson
	Logan (John A.) College	Carterville
	Loyola University of Chicago	Chicago
	MacMurray College	Jacksonville
	McHenry County College	Crystal Lake
	McKendree College	Lebanon
	Meadville Theological School	Lombard
	Millikin University	Decatur
	Moraine Valley Community College	Palos Hills
	National College of Chiropractic	Lombard
	North Central College	Naperville
	Northeastern Illinois University	Chicago
	Northern Baptist Theological Seminary	Lombard
	Northern Illinois University	DeKalb
	Northwestern University	Evanston
	Oakton Community College	Morton Grove
	Olivet Nazarene College	Kankakee
	Olney Central College	Mt. Carmel
	Prairie State Community College	Chicago Heights
	Rockford College	Rockford
	Rock Valley College	Rockford
	Roosevelt University	Chicago
	Rush University, College of Nursing and Allied Health Sciences	Chicago
	Rush University, Rush Medical College	Chicago
	Sangamon State University	Springfield
	Sauk Valley College	Dixon
	Southern Illinois University	Carbondale
	Southern Illinois University	Edwardsville
	Spertus College of Judaica	Chicago
	Spoon River College	Canton
	Springfield College in Illinois	Springfield

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	State Community College of East Saint Louis, Illinois	East St. Louis
	Thornton Community College	South Holland
	Triton College	River Grove
	University of Health Sciences, The Chicago Medical School	Chicago
	University of Illinois at Chicago Circle	Chicago
	University of Illinois at the Medical Center, School of Public Health	Chicago
	University of Illinois at Urbana-Champaign	Urbana-Champaign
	Wabash Valley College	Mt. Carmel
	Waubonsee Community College	Sugar Grove
	Western Illinois University	Macomb
	Wheaton College	Wheaton
	William Rainey Harper College	Palatine
IN	Anderson College	Anderson
	Associated Mennonite Biblical Seminary	Elkhart
	Ball State University	Muncie
	Bethel College	Mishawaka
	Butler University	Indianapolis
	DePauw University	Greencastle
	Earlham College	Richmond
	Franklin College	Franklin
	Goshen College	Goshen
	Grace College	Winona Lake
	Hanover College	Hanover
	Holy Cross Junior College	Notre Dame
	Huntington College	Huntington
	Indiana Central College	Indianapolis
	Indiana Institute of Technology	Fort Wayne
	Indiana State University	Evansville
	Indiana University	Bloomington
	Indiana University-East	Richmond
	Indiana University-Kokomo	Kokomo
	Indiana University-Northwest	Gary
	Indiana University-South Bend	South Bend
	Indiana University-Southeast	New Albany
	Indiana University-Purdue University at Fort Wayne	Fort Wayne
	Indiana Vocational Technical College	Indianapolis
	International Junior College	Fort Wayne
	Manchester College	North Manchester
	Marian College	Indianapolis
	Marion College	Marion
	Oakland College	Oakland City
	Purdue State University	Muncie
	Purdue University	West Lafayette
	Purdue University-Calumet	Calumet
	Purdue University-North Central	Westville
	Rose-Hulman Institute of Technology	Terre Haute
	Saint Joseph's College	Rensselaer
	Saint Mary's College	Notre Dame
	Saint Mary of the Woods College	Saint Mary of the Woods
	Saint Meinard College	St. Meinard
	Taylor University	Upland
	Tri-State University	Angola
	University of Evansville	Evansville
	University of Notre Dame	South Bend
	Valparaiso University	Valparaiso
	Vincennes University	Vincennes
	Wabash College	Crawfordsville

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
IA	Area One Vocational-Technical School	Calmar and Dubuque
	Briar Cliff College	Sioux City
	Central College	Pella
	Clarke College	Dubuque
	Coe College	Cedar Rapids
	Cornell College	Mt. Vernon
	Des Moines Area Community College	Ankeny
	Drake University	Des Moines
	Ellsworth Community College	Iowa Falls
	Grinnell College	Grinnell
	Hawkeye Institute of Technology	Waterloo
	Iowa Central Community College	Fort Dodge
	Iowa Lakes Community College	Estherville
	Iowa State University	Ames
	Iowa Wesleyan College	Mount Pleasant
	Iowa Western Community College	Council Bluffs
	Kirkwood Community College	Cedar Rapids
	Loras College	Dubuque
	Luther College	Decorah
	Marshalltown Community College	Marshalltown
	Marycrest College	Davenport
	Morningside College	Sioux City
	Mount Mercy College	Cedar Rapids
	North Iowa Area Community College	Mason City
	Open Bible College	Des Moines
	Palmer College of Chiropractic	Davenport
	Simpson College	Indianola
	Southeastern Community College	Burlington
	Southwestern Community College	Creston
	University of Dubuque	Dubuque
	University of Dubuque Theological Seminary	Dubuque
	University of Iowa	Iowa City
	University of Northern Iowa	Cedar Falls
	Upper Iowa University	Fayette
	Wartburg College	Waverly
	Wartburg Seminary	Dubuque
	Westmar College	LeMars
	Western Iowa Technical Community College	Sioux City
KS	Allen County Community Junior College	Iola
	Baker University	Baldwin
	Barton County Community College	Great Bend
	Benedictine College	Atchison
	Bethel College	North Newton
	Central College	McPherson
	Cloud County Community College	Concordia
	Coffeyville Community Junior College	Coffeyville
	Colby Community College	Colby
	Cowley County Community College	Arkansas City
	Dodge City Community College	Dodge City
	Donnelly College	Kansas City
	Emporia Kansas State College	Emporia
	Fort Hays Kansas State College	Hays
	Fort Scott Community College	Fort Scott
	Friends Bible College	Haviland
	Garden City Community College	Garden City
	Haskell Indian Junior College	Lawrence
	Hesston College	Hesston
	Highland Community Junior College	Highland
	Hutchinson Community Junior College	Hutchinson
	Independence Community Junior College	Independence
	Johnson County Community College	Overland Park
	Kansas City Community College	Kansas City

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Kansas Newman College	Wichita
	Kansas State College of Pittsburg	Pittsburg
	Kansas State University	Manhattan
	Kansas Technical Institute	Salina
	Kansas Wesleyan	Salina
	Labette Community Junior College	Parsons
	Manhattan Christian College	Manhattan
	Marymount College of Kansas	Salina
	McPherson College	McPherson
	Mid-America Nazarene College	Olathe
	Neosho County Community Junior College	Chanute
	Ottawa University	Ottawa
	Pratt Community College	Pratt
	Saint John's College	Winfield
	Saint Mary College	Leavenworth
	Saint Mary of the Plains College	Dodge City
	Seward County Community College	Liberal
	Southwestern College in Kansas	Winfield
	Sterling College	Sterling
	Tabor College	Hillsboro
	The University of Kansas	Lawrence
	Washburn University of Topeka	Topeka
	Wichita State University	Wichita
KY	Alice Lloyd College	Pippa Passes
	Asbury College	Wilmore
	Bellarmine College	Louisville
	Berea College	Berea
	Brescia College	Owensboro
	Campbellsville College	Campbellsville
	Centre College of Kentucky	Danville
	Cumberland College	Williamsburg
	Eastern Kentucky University	Richmond
	Georgetown College	Georgetown
	Jefferson Vocational Regional Office	Jeffersontown
	Kentucky Christian College	Grayson
	Kentucky State University	Frankfort
	Kentucky Wesleyan College	Owensboro
	Lees Junior College	Jackson
	Lindsey Wilson College	Columbia
	Midway College	Midway
	Morehead State University	Morehead
	Murray State University	Murray
	Pikeville College	Pikeville
	Saint Catharine College	Saint Catharine
	Southeastern Christian College	Winchester
	Sue Bennett College	London
	Thomas More College	Fort Mitchell
	Transylvania University	Lexington
	University of Kentucky	Lexington
	University of Kentucky Community College System	Lexington
	University of Louisville	Louisville
	Western Kentucky University	Bowling Green
LA	Bossier Parish Community College	Bossier City
	Centenary College of Louisiana	Shreveport
	Delgado College	New Orleans
	Dillard University	New Orleans
	Grambling State University	Grambling
	Louisiana State University-Central Office	Baton Rouge

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Louisiana State University and Agricultural and Mechanical College at Baton Rouge	Baton Rouge
	Louisiana State University-Alexandria	Alexandria
	Louisiana State University-Eunice	Eunice
	Louisiana State University-Shreveport	Shreveport
	University of New Orleans	New Orleans
	Louisiana Tech University	Ruston
	McNeese State University	Lake Charles
	New Orleans Baptist Theological Seminary	New Orleans
	Northeast Louisiana University	Monroe
	Northwestern State University of Louisiana	Natchitoches
	Notre Dame Seminary School of Theology	New Orleans
	Our Lady of Holy Cross College	New Orleans
	Saint Bernard Parish Community College	Chalmette
	Saint Joseph Seminary College	Saint Benedict
	Saint Mary's Dominican College	New Orleans
	Southern University in New Orleans	New Orleans
	Tulane University of Louisiana	New Orleans
	Xavier University of Louisiana	New Orleans
ME	Bowdoin College	Brunswick
	Colby College	Waterville
	College of the Atlantic	Bar Harbor
	Eastern Maine Vocational and Technical Institute	Bangor
	Maine Maritime Academy	Castine
	Masson College	Springvale
	South Maine Vocational and Technical Institute	South Portland
	Unity College	Unity
	University of Maine at Orono	Orono
MD	Bowie State College	Bowie
	Catonsville Community College	Catonsville
	Charles County Community College	La Plata
	Chesapeake College	Wye Mills
	Columbia Union College	Takoma Park
	Community College of Baltimore	Baltimore
	Dundalk Community College	Baltimore
	Essex Community College	Baltimore County
	Garrett Community College	McHenry
	Goucher College	Towson
	Hagerstown Junior College	Hagerstown
	Harford Community College	Bel Air
	Hood College	Frederick
	Howard Community College	Columbia
	Johns Hopkins University	Baltimore
	Loyola College	Baltimore
	Montgomery College	Rockville
	Saint John's College	Annapolis
	Saint Mary's College of Maryland	Saint Mary's City
	Towson State College	Baltimore
	University of Baltimore	Baltimore
	University of Maryland	College Park
	Villa Julie College	Stevenson
	Washington College	Chestertown

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
MA	Amherst College	Amherst
	Anna Maria College	Paxton
	Assumption College	Worcester
	Bay Path Junior College	Longmeadow
	Bentley College	Waltham
	Boston College	Chestnut Hill
	Boston University	Boston
	Gordon College	Wenham
	Hampshire College	Amherst
	Harvard University	Cambridge
	Lasell Junior College	Auburndale
	Lesley College	Cambridge
	Massachusetts Institute of Technology	Cambridge
	Merrimack College	North Andover
	Mount Holyoke College	South Hadley
	Nichols College	Dudley
	Northeastern University	Boston
	Regis College	Weston
	Simon's Rock	Great Barrington
	Smith College	Northampton
	Southeastern Massachusetts University	North Darmouth
	Springfield College	Springfield
	Springfield Technical Community College	Springfield
	Stonehill College	North Easton
	Suffolk University	Boston
	Tufts University	Medford
	University of Massachusetts	Boston
	Wentworth Institute	Boston
	Wheelock College	Boston
	Williams College	Williamstown
	Worcester Junior College	Worcester
	Worcester Polytechnic Institute	Worcester
MI	Alma College	Alma
	Alpena Community College	Alpena
	Andrews University	Berrien Springs
	Aquinas College	Grand Rapids
	Bay de Noc Community College	Escanaba
	Calvin College	Grand Rapids
	Calvin Theological Seminary	Grand Rapids
	Central Michigan University	Mount Pleasant
	Concordia Lutheran Junior College	Ann Arbor
	Delta College	University Center
	Detroit Institute of Technology	Detroit
	Eastern Michigan University	Ypsilanti
	Ferris State College	Big Rapids
	General Motors Institute	Flint
	Grace Bible College	Wyoming
	Grand Rapids Baptist College	Grand Rapids
	Grand Rapids Junior College	Grand Rapids
	Grand Valley State College	Allendale
	Highland Park Community College	Highland Park
	Hillsdale College	Hillsdale
	Hope College	Holland

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Jackson Community College	Jackson
	Kalamazoo College	Kalamazoo
	Kalamazoo Valley Community College	Kalamazoo
	Kirtland Community College	Roscommon
	Lake Michigan College	Benton Harbor
	Lake Superior State College	Saulte Ste. Marie
	Lansing Community College	Lansing
	Macomb County Community College	Warren
	Madonna College	Livonia
	Marygrove College	Detroit
	Mercy College of Detroit	Detroit
	Merrill-Palmer Institute	Detroit
	Michigan Department of Education-Environmental Guidelines	Lansing
	Michigan State University	East Lansing
	Michigan Technological University	Houghton
	Mid Michigan Community College	Harrison
	Monroe County Community College	Monroe
	Montcalm Community College	Sidney
	Mott Community College	Flint
	Muskegon Business College	Muskegon
	Muskegon Community College	Muskegon
	Northern Michigan University	Marquette
	Northwestern Michigan College	Traverse City
	Oakland Community College	Bloomfield Hills
	Oakland University	Rochester
	Olivet College	Olivet
	Saginaw Valley State College	University Center
	Saint Mary's College	Orchard Lake
	Schoolcraft College	Livonia
	Shaw College at Detroit	Detroit
	Southwestern Michigan College	Dowagiac
	Spring Arbor College	Spring Arbor
	Suomi College	Hancock
	University of Detroit	Detroit
	University of Michigan	Ann Arbor
	Walsh College	Troy
	Washtenaw Community College	Ann Arbor
	Wayne County Community College	Detroit
	Wayne State University	Detroit
	Western Michigan University	Kalamazoo
	West Shore Community College	Scottville
	Western Theological Seminary	Holland
MN	Anoka-Ramsey Community College	Coon Rapids
	Augsburg College	Minneapolis
	Austin Community College	Austin
	Bemidji State University	Bemidji
	Bethany Lutheran College	Mankato
	Brainerd Community College	Brainerd
	Carleton College	Northfield
	College of Saint Benedict	St. Joseph
	College of St. Catherine	St. Paul
	College of St. Scholastica	Duluth
	College of St. Thomas	St. Paul
	Concordia College	Moorhead
	Crosier Seminary Junior College	Onamia
	Dr. Martin Luther College	New Ulm
	Fergus Falls Community College	Fergus Falls
	Hibbing Community College	Hibbing
	Itasca Community College	Grand Rapids
	Lakewood Community College	White Bear Lake
	Luther Theological Seminary	St. Paul
	Macalester College	St. Paul
	Mankato State University	Mankato

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Mesabi Community College	Virginia
	Metropolitan Community College	Minneapolis
	Metropolitan State University	St. Paul
	Minneapolis College of Art and Design	Minneapolis
	Minnesota Bible College	Rochester
	Moorhead State College	Moorhead
	Normandale Community College	Bloomington
	North Hennepin Community College	Minneapolis
	Northland Community College	Thief River Falls
	Northwestern College	Roseville
	Rainy River Community College	International Falls
	Rochester Community College	Rochester
	Saint John's University	Collegeville
	Saint Mary's College	Winona
	Southwest Minnesota State College	Marshall
	St. Cloud Area Vocational Technical Institute	St. Cloud
	St. Cloud State University	St. Cloud
	St. Mary's Junior College	Minneapolis
	St. Paul Bible College	Bible College
	United Theological Seminary of the Twin Cities	New Brighton
	University of Minnesota	Minneapolis
	Vermilion Community College	Ely
	William Mitchell College of Law	St. Paul
	Winona State University	Winona
	Worthington Community College	Worthington
MS	Alcorn State University	Lorman
	Belhaven College	Jackson
	Clarke College	Newton
	Coahama Junior College	Clarksdale
	Copiah-Lincoln Junior College	Wesson
	Delta State University	Cleveland
	East Central Junior College	Decatur
	East Mississippi Junior College	Scooba
	Hinds Junior College	Raymond
	Holmes Junior College	Goodman
	Itawamba Junior College	Fulton
	Jackson State University	Jackson
	John C. Stennis Vocational Complex	Dekalb
	Jones County Junior College	Ellisville
	Mary Holmes College	West Point
	Meridian Junior College	Meridian
	Millsaps College	Jackson
	Mississippi College	Clinton
	Mississippi Delta Junior College	Moorhead
	Mississippi Gulf Coast Junior College	Perkinston
	Mississippi Industrial College	Holly Springs
	Mississippi State University	Mississippi State
	Mississippi University for Women	Columbus
	Northeast Mississippi Junior College	Booneville
	Northwest Mississippi Junior College	Senatobia
	Pearl River Junior College	Poplarville
	Rust College	Holly Springs
	Southwest Mississippi Junior College	Summit
	Tougaloo College	Tougaloo
	University of Mississippi	University
	University of Mississippi Medical Center	Jackson
	University of Southern Mississippi	Hattiesburg
	Utica Junior College	Utica
	Wesley College	Florence
	William Carey College	Hattiesburg
	Wood Junior College	Mathiston

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
MO	Assemblies of God Graduate School	Springfield
	Avila College	Kansas City
	Calvary Bible College	Kansas City
	Central Bible College	Springfield
	Central Methodist College	Fayette
	Central Missouri State University	Warrensburg
	Columbia College	Columbia
	Concordia Seminary	St. Louis
	Cottey College	Nevada
	Crowder College	Neosho
	Culver-Stockton College	Canton
	Fontbonne College	St. Louis
	Hannibal Lagrange College	Hannibal
	Harris Teachers College	St. Louis
	Jefferson College	Hillsboro
	Kansas City Art Institute	Kansas City
	Kansas City College of Osteopathic Medicine	Kansas City
	Logan College of Chiropractic	Chesterfield
	Longview Community College	Kansas City
	Maple Woods Community College	Kansas City
	Maryville College	St. Louis
	Meramec Community College	St. Louis
	Missouri Baptist College	St. Louis
	Missouri Southern State College	Joplin
	Moberly Area Junior College	Moberly
	Northeast Missouri State University	Kirksville
	Northwest Missouri State University	Maryville
	Rockhurst College	Kansas City
	Saint Louis College of Pharmacy	St. Louis
	Saint Louis Community College at Forest Park	St. Louis
	Saint Louis University	St. Louis
	Saint Paul's College	Concordia
	School of the Ozarks	Point Lookout
	Southwest Missouri State University	Springfield
	State Fair Community College	Sedalia
	Stephen's College	Columbia
	Tarkio College	Tarkio
	The Principia	St. Louis
	Three Rivers Community College	Poplar Bluff
	University of Missouri-Columbia	Columbia
	University of Missouri-Kansas City	Kansas City
	University of Missouri-Rolla	Rolla
	University of Missouri-St. Louis	St. Louis
	Washington University	St. Louis
	Water and Wastewater Technical School	Neosho
	Webster College	Webster
	Westminster College	Fulton
	William Jewell College	Kansas City
MT	Carroll College	Helena
	College of Great Falls	Great Falls
	Dawson College	Glendive
	Eastern Montana College	Billings
	Flathead Valley Community College	Kalispell
	Miles Community College	Miles City
	Montana College of Mineral Science and Technology	Butte
	Montana State University	Bozeman
	Northern Montana College	Havre
	Rocky Mountain College	Billings
	University of Montana	Missoula
	Western Montana College	Dillon

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
NE	Central Technical Community College	Hastings
	Chadron State College	Chadron
	College of Saint Mary	Omaha
	Concordia College	Seward
	Creighton University	Omaha
	Dana College	Blair
	Doane College	Crete
	Grace College of the Bible	Omaha
	Hastings College	Hastings
	Kearney State College	Kearney
	McCook Community College	McCook
	Midland Lutheran College	Fremont
	Mid-Plains Community College	North Platte
	Northeast Technical Community College	Norfolk
	Platte Technical Community College	Columbus
	Southeast Community College	Lincoln
	Union College	Lincoln
	University of Mid-America	Lincoln
	University of Nebraska	Lincoln
	Wayne State College	Wayne
NV	University of Nevada-Las Vegas	Las Vegas
	University of Nevada-Reno	Reno
	Clark County Community College	Las Vegas
	Northern Nevada Community College	Elko
	Sierra Nevada College	Incline Village
	Western Nevada Community College	Carson City
NH	Colby-Sawyer College	New London
	Dartmouth College	Hanover
	Franklin Pierce College	Rindge
	New England College	Henniker
	NH Technical Institute	Concord
	NH Voc-Tech College of Berlin	Berlin
	NH Voc-Tech College of Claremont	Claremont
	NH Voc-Tech College of Laconia	Laconia
	NH Voc-Tech College of Manchester	Manchester
	NH Voc-Tech College of Nashua	Nashua
	NH Voc-Tech College of Portsmouth	Portsmouth
	Saint Anselm's College	Manchester
	University of New Hampshire	Durham
	White Pines College	Chester
NJ	Atlantic Community College	Mays Landing
	Bergen Community College	Paramus
	Brookdale Community College	Lincroft
	Burlington County College	Penberton
	Camden County College	Caldwell
	Centenary College for Women	Hackettstown
	County College of Morris	Dover
	Cumberland County College	Vineland
	Drew University	Madison
	Fairleigh Dickinson University	Rutherford
	Gloucester County College	Sewell
	Kean College of New Jersey	Union
	Mercer County Community College	Trenton
	Middlesex County College	Edison
	Montclair State College	Upper Montclair
	New Jersey Institute of Technology	Newark
	Ocean County College	Toms River
	Passaic County Community College	Paterson
	Princeton University	Princeton

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Rider College	Trenton
	Rutgers the State University	New Brunswick
	Stevens Institute of Technology	Hoboken
	Trenton State College	Trenton
	Union College	Cranford
	Union County Technical Institute	Scotch Plains
	William Paterson College	Wayne
NM	College of the Southwest	Hobbs
	Eastern New Mexico University-Main Campus	Portales
	Eastern New Mexico University-Roswell	Roswell
	New Mexico Highlands University	Las Vegas
	New Mexico Institute of Mining and Technology	Socorro
	New Mexico Junior College	Hobbs
	New Mexico Military Institute	Roswell
	New Mexico State University-Las Cruces	Las Cruces
	New Mexico State University-San Juan	San Juan
	University of Albuquerque	Albuquerque
	University of New Mexico-Main Campus	Albuquerque
NY	Adelphi University	Garden City
	Albany College Pharmacy	Albany
	Albany Law School	Albany
	Alfred University	Alfred
	Bard College	Annandale-on-Hudson
	Bronx Community College	Bronx
	Brooklyn Law School	Brooklyn
	Canisius	Buffalo
	City University of New York	New York
	Clarkson College of Technology	Potsdam
	Colgate University	Hamilton
	College of Mt. Saint Vincent	Riverdale
	College of Saint Rose	Albany
	Columbia University	New York
	Concordia College	Bronxfille
	Cornell University	Ithaca
	Dowling College	Oakdale Long Island
	D'Youville College	Buffalo
	Erie Community College	Buffalo
	Hamilton College	Clinton
	Hartwick College	Oneonta
	Hilbert College	Hamburg
	Hobart-William Smith Colleges	Geneva
	Hofstra University	Hempstead
	Houghton College	Houghton
	Hudson Valley Community College	Troy
	Hunter College	New York
	Ithaca College	Ithaca
	King's College	Briarcliff Manor
	Long Island University	Greenvale
	Manhattan College	Bronx
	Medaille College	Buffalo
	Mercy College	Dobbs Ferry
	Molloy College	Rockville Centre
	New School for Social Research	New York
	New York Institute of Technology	Old Westbury
	New York Law School	New York
	Niagara University	Niagara University

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Paul Smith's College of Arts & Science	Paul Smiths
	Polytechnic Institute of New York	Brooklyn
	Rensselaer Polytechnic Institute	Troy
	Roberts Wesleyan College	Rochester
	Rochester Institute of Technology	Rochester
	Rockefeller University	New York
	Saint Banaventure University	Saint Bonaventure
	Saint John Fisher College	Rochester
	Saint John's University	Jamaica
	Saint Lawrence University	Canton
	Saint Thomas Aquinas College	Sparkhill
	Skidmore College	Saratoga Springs
	Southampton College	Southampton
	State University of New York at Buffalo	Buffalo
	Syracuse University	Syracuse
	The Cooper Union	New York
	Trocaire College	Buffalo
	Ulster County Community College	Stone Ridge
	University of Rochester	Rochester
	Vassar College	Poughkeepsie
	Wagner College	Staten Island
	Webb Institute of Naval Architecture	Glen Cove
	Westchester Community College	Valhalla
NC	Anson Technical Institute	Ansonville
	Appalachian State University	Boone
	Asheville Buncombe Technical Institute	Asheville
	Atlantic Christian College	Wilson
	Beaufort County Technical Institute	Washington
	Belmont Abbey College	Belmont
	Bennett College	Greensboro
	Bladen Technical Institute	Dublin
	Blue Ridge Technical Institute	Flat Rock
	Brevard College	Brevard
	Campbell College	Buies Creek
	Cape Fear Technical Institute	Wilmington
	Carteret Technical Institute	Morehead City
	Catawba College	Salisbury
	Catawba Valley Technical Institute	Hickory
	Central Carolina Technical Institute	Sanford
	Central Piedmont Community College	Charlotte
	Chowan College	Murfreesboro
	Cleveland County Technical Institute	Shelby
	Coastal Carolina Community College	Jacksonville
	College of the Albemarle	Elizabeth City
	Craven Community College	New Bern
	Davidson College	Davidson
	Davidson County Community College	Lexington
	Duke University	Durham
	Durham College	Durham
	East Carolina University	Greenville
	Elon College	Elon College
	Fayetteville State University	Fayetteville
	Fayetteville Technical Institute	Fayetteville
	Gardner Webb College	Boiling Springs
	Gaston College	Dallas
	Greensboro College	Greensboro
	Guilford College	Greensboro
	Guilford Technical Institute	Jamestown
	Halifax Community College	Weldon
	Haywood Technical Institute	Clyde
	High Point College	High Point
	Isothermal Community College	Spindale
	James Sprunt Institute	Kenansville
	Johnson C. Smith University	Charlotte

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Johnston Technical Institute	Smithfield
	Lees-McCrae College	Banner Elk
	Lenoir Community College	Kinston
	Lenoir-Rhyne College	Hickory
	Livingstone College	Salisbury
	Louisburg College	Louisburg
	Mars Hill College	Mars Hill
	Martin Community College	Williamston
	Mayland Technical Institute	Spruce Pine
	McDowell Technical Institute	Marion
	Meredith College	Raleigh
	Methodist College	Fayetteville
	Montreat-Anderson College	Montreat
	Mount Olive College	Mount Olive
	Nash Technical Institute	Rocky Mount
	North Carolina Agricultural and Technical State University	Greensboro
	North Carolina Central University	Durham
	North Carolina State University	Raleigh
	North Carolina Wesleyan College	Rocky Mount
	Pembroke State University	Pembroke
	Pfeiffer College	Misenheimer
	Piedmont Bible College	Winston-Salem
	Piedmont Technical Institute	Roxboro
	Pitt Technical Institute	Greenville
	Queens College	Charlotte
	Randolph Technical Institute	Asheboro
	Richmond Technical Institute	Hamlet
	Roanoke-Chowan Technical Institute	Ahoskie
	Robeson Technical Institute	Lumberton
	Rockingham Community College	Wentworth
	Rowan Technical Institute	Salisbury
	Saint Andrews Presbyterian College	Laurinburg
	Saint Augustine's College	Raleigh
	Saint Mary's College	Raleigh
	Salem College	Winston-Salem
	Sampson Technical Institute	Clinton
	Sandhills Community College	Carthage
	Shaw University	Raleigh
	Stanly Technical Institute	Albermarle
	Surry Community College	Dobson
	Technical Institute of Alamance	Burlington
	Tri-County Technical Institute	Murphy
	University of North Carolina at Chapel Hill	Chapel Hill
	University of North Carolina at Charlotte	Charlotte
	University of North Carolina at Greensboro	Greensboro
	University of North Carolina at Wilmington	Wilmington
	Wake Forest University	Winston-Salem
	Wake Technical Institute	Raleigh
	Warren Wilson College	Swannanoa
	Wayne Community College	Goldsboro
	Western Carolina University	Cullowhee
	Western Piedmont Community College	Morganton
	Wilkes Community College	Wilkesboro
	Wilson County Technical Institute	Wilson
	Wingate College	Wingate
	Winston-Salem State University	Winston-Salem

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
ND	Bismarck Junior College	Bismarck
	Dickinson State College	Dickinson
	Jamestown College	Jamestown
	Lake Region Junior College	Devils Lake
	Mary College	Bismarck
	Mayville State College	Mayville
	Minot State College	Minot
	North Dakota State School of Science	Wahpeton
	North Dakota State University-Main Campus	Fargo
	North Dakota State University-Bottineau	Bottineau
	Trinity Bible Institute	Ellendale
	University of North Dakota-Main Campus	Grand Forks
	University of North Dakota-Williston	Williston
OH	Antioch College	Yellow Springs
	Art Academy of Cincinnati	Cincinnati
	Bluffton College	Bluffton
	Capital University	Columbus
	Case Western Reserve University	Cleveland
	Central Ohio Technical College	Newark
	Central State University	Wilberforce
	Cincinnati Bible College	Cincinnati
	Cincinnati Technical College	Cincinnati
	Clark Technical College	Springfield
	Cleveland Institute of Art	Cleveland
	Cleveland Institute of Music	Cleveland
	Cleveland State University	Cleveland
	College of Mount St. Joseph on the Ohio	Cincinnati
	College of Steubenville	Steubenville
	College of Wooster	Wooster
	Columbus College of Art and Design	Columbus
	Columbus Technical Institute	Columbus
	Cuyahoga Community College	Cleveland
	Davis Junior College	Toledo
	Defiance College	Defiance
	Denison University	Granville
	Franklin University	Columbus
	Hebrew Union College	Cincinnati
	Heidelberg College	Tiffin
	Hiram College	Hiram
	Hocking Technical College	Nelsonville
	Jefferson County Technical Institute	Steubenville
	John Carroll University	Cleveland
	Josephinum College of Liberal Arts	Worthington
	Kent State University	Kent
	Kenyon College	Gambier
	Kettering College of Medical Arts	Kettering
	Lakeland Community College	Mentor
	Lima Technical College	Lima
	Lorain County Community College	Elyria
	Lutheran Theological Seminary	Columbus
	Malone College	Canton
	Marietta College	Marietta
	Marion Technical College	Marion
	Medical College of Ohio	Toledo
	Miami-Jacobs Junior College	Dayton
	Miami University	Oxford
	Mount Union College	Alliance
	Mount Vernon Nazarene College	Mount Vernon
	Muskingum Area Technical College	Zanesville
	Muskingum College	New Concord
	National Training and Operational Technology Center (EPA)	Cincinnati
	North Central Technical College	Mansfield

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Northwest Technical College	Archbold
	Notre Dame College	Cleveland
	Oberlin College	Oberlin
	Ohio Board of Regents-Technical Education Offerings	Columbus
	Ohio Dominican College	Columbus
	Ohio Northern University	Ada
	Ohio State University	Columbus
	Ohio University	Athens
	Ohio Wesleyan University	Delaware
	Owens Technical College	Perrysburg
	Saint John College of Cleveland	Cleveland
	Sinclair Community College	Dayton
	Stark Technical College	Canton
	Tiffin University	Tiffin
	United Theological Seminary	Dayton
	University of Cincinnati	Cincinnati
	University of Dayton	Dayton
	University of Toledo	Toledo
	Urbana College	Urbana
	Washington Technical College	Marietta
	Wittenberg University	Springfield
	Wright State University	Dayton
	Xavier University	Cincinnati
	Youngstown State University	Youngstown
OK	Bacone College	Muskogee
	Bartlesville Weslyan College	Bartlesville
	Bethany Nazarene College	Bethany
	Cameron University	Lawton
	Carl Albert Junior College	Poteau
	Central State University	Edmond
	Claremore Junior College	Claremore
	Connors State College	Warner
	East Central Oklahoma State University	Ada
	Eastern Oklahoma State College	Wilburton
	El Reno Junior College	El Reno
	Hillsdale Free Will Baptist College	Moore
	Midwest Christian College	Oklahoma City
	Murray State College	Tishomingo
	Northeastern Oklahoma Agricultural and Mechanical College	Miami
	Northeastern Oklahoma State University	Tahlequah
	Northern Oklahoma College	Tonkawa
	Northwestern Oklahoma State University	Alva
	Oklahoma Baptist University	Shawnee
	Oklahoma Christian College	Oklahoma City
	Oklahoma City University	Oklahoma City
	Oklahoma Panhandle State University	Goodwell
	Oklahoma School of Business, Accountancy, Law and Finance	Tulsa
	Oklahoma State University-Main Campus	Stillwater
	Oklahoma State University-Oklahoma City	Oklahoma City
	Oral Roberts University	Tulsa
	Oscar Rose Junior College	Midwest City
	Phillips University	Enid
	Saint Gregory's College	Shawnee
	Sayre Junior College	Sayre
	Seminole Junior College	Seminole
	Southeastern Oklahoma State University	Durant
	South Oklahoma City Junior College	Oklahoma City
	Southwestern College	Oklahoma City
	Tulsa Junior College	Tulsa
	University of Oklahoma-Central Office	Norman

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	University of Oklahoma-Health Science Center	Oklahoma City
	University of Science and Arts of Oklahoma	Chickasha
	University of Tulsa	Tulsa
	Western Oklahoma State College	Altus
OR	Blue Mountain Community College	Pendleton
	Chemeketa Community College	Salem
	Clackamas Community College	Oregon City
	Clatsop Community College	Astoria
	Columbia Christian College	Portland
	Concordia College	Portland
	George Fox College	Newberg
	Judson Baptist College	Portland
	Lane Community College	Eugene
	Lewis and Clark College	Portland
	Linfield College	McMinnville
	Linn-Benton Community College	Albany
	Marylhurst Education Center	Marylhurst
	Mount Hood Community College	Gresham
	Multnomah School of the Bible	Portland
	Museum Art School	Portland
	Oregon State Higher Education District	
	Eastern Oregon State College	La Grande
	Oregon College of Education	Monmouth
	Oregon Institute of Technology	Klamath Falls
	Oregon State University	Corvallis
	Portland State University	Portland
	Southern Oregon State College	Ashland
	University of Oregon-Health Sciences Center	Portland
	Pacific University	Forest Grove
	Reed College	Portland
	Southwestern Oregon Community College	Coos Bay
	Treasure Valley Community College	Ontario
	Umpqua Community College	Rosenburg
	University of Portland	Portland
	Warner Pacific College	Portland
	Western Baptist Bible College	Salem
	Western Conservative Baptist Seminary	Portland
	Western Evangelical Seminary	Portland
	Williamette University	Salem
PA	Allegheny College	Meadville
	Allentown College of St. Francis De Sales	Center Valley
	Alliance College	Cambridge Springs
	Beaver College	Glenside
	Bloomsburg State College	Bloomsburg
	Bucks County Community College	Newton
	Butler County Community College	Butler
	Cabrini College	Radnor
	California State College	California
	Carlow College	Pittsburgh
	Carnegie-Mellon University	Pittsburgh
	Cedar Crest College	Allentown
	Chestnut Hill College	Philadelphia
	Cheyney State College	Cheyney
	Clarion State College	Clarion
	Community College of Allegheny County	Pittsburgh
	Community College of Beaver County	Monaca
	Community College of Philadelphia	Philadelphia
	Delaware Valley College of Science and Agriculture	Doylestown

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Dickinson College	Carlisle
	Drexel University	Philadelphia
	The Dropsie University	Philadelphia
	Duquesne University	Pittsburgh
	Eastern College	Saint Davids
	East Stroudsburg State College	East Stroudsburg
	Edinboro State College	Edinboro
	Franklin-Marshall College	Lancaster
	Gannon College	Erie
	Geneva College	Beaver Falls
	Gettysburg College	Gettysburg
	Gwynedd-Mercy College	Gwynedd Valley
	Harcum Junior College	Bryn Mawr
	Haverford College	Haverford
	Indiana University of Pennsylvania	Indiana
	Juniata College	Huntingdon
	Keystone Junior College	La Plume
	King's College	Wilkes-Barre
	Lafayette College	Easton
	La Roche College	Allison Park
	La Salle College	Philadelphia
	Lehigh University	Bethlehem
	Lincoln University	Lincoln University
	Lock Haven State College	Lock Haven
	Lycoming College	Williamsport
	Mansfield State College	Mansfield
	Marywood College	Scranton
	Mercyhurst College	Erie
	Millersville State College	Millersville
	Montgomery County Community College	Blue Bell
	Northeastern Christian Junior College	Villanova
	Pennsylvania State University	University Park
	Philadelphia College of Pharmacy and Science	Philadelphia
	Point Park College	Pittsburgh
	Reading Area Community College	Reading
	Saint Fidelis College	Herman
	Saint Francis College	Loretto
	Saint Joseph's College	Philadelphia
	Saint Vincent College	Latrobe
	Seton Hill College	Greensburg
	Slippery Rock State College	Slippery Rock
	Spring Garden College	Chestnut Hill
	Susquehanna University	Selinsgrove
	Swarthmore College	Swarthmore
	Temple University	Philadelphia
	University of Pennsylvania	Philadelphia
	University of Pittsburg	Pittsburgh
	University of Scranton	Scranton
	Ursinus College	Collegeville
	Villa Maria College	Erie
	Villanova University	Villanova
	Waynesburg College	Waynesburg
	West Chester State College	West Chester
	Westminster College	New Wilmington
	Widener College	Chester
	Wilkes College	Wilkes-Barre
	Williamsport Area Community College	Williamsport
	Wilson College	Chambersburg
PR	Inter American University of Puerto Rico	San German
	The Catholic University of Puerto Rico	Ponce
	University of Puerto Rico	Mayaguez
	University of Puerto Rico	Rio Pedras

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
RI	Brown University	Providence
	Providence College	Providence
	Roger Williams College	Bristol
	University of Rhode Island	Kingston
SC	Aiken Technical Education Center	Aiken
	Baptist College	Charleston
	Bob Jones University	Greenville
	Central Wesleyan College	Central
	Citadel Military College of South Carolina	Charleston
	Claflin College	Orangeburg
	Clemson University	Clemson
	Coastal Carolina College	Conway
	Coker College	Hartsville
	College of Charleston	Charleston
	Columbia College	Columbia
	Columbia Bible College	Columbia
	Converse College	Spartanburg
	Erskine College	Due West
	Florence-Darlington Technical College	Florence
	Francis Marion College	Florence
	Furman University	Greenville
	Greenville Technical College	Greenville
	Lander College	Greenwood
	Limestone College	Gaffney
	Morris College	Sumter
	Newberry College	Newberry
	North Greenville College	Tigerville
	Orangeburg-Calhoun Technical College	Orangeburg
	Piedmont Technical College	Greenwood
	South Carolina State College	Orangeburg
	Sumter Area Technical College	Sumter
	Tri County Technical College	Pendleton
	Trident Technical College	North Charleston
	University of South Carolina	Columbia
	University of South Carolina at Aiken	Aiken
	University of South Carolina at Beaufort	Beaufort
	University of South Carolina at Spartanburg	Spartanburg
	University of South Carolina at Union	Union
	Voorhees College	Denmark
	Winthrop College	Rock Hill
	Wofford College	Spartanburg
SD	Augustana College	Sioux Falls
	Black Hills State College	Spearfish
	Dakota Wesleyan University	Mitchell
	Freeman Junior College	Freeman
	National College of Business	Rapid City
	Northern State College	Aberdeen
	Presentation College	Aberdeen
	Sioux Falls College	Sioux Falls
	South Dakota School of Mines and Technology	Rapid City
	South Dakota State University	Brookings
	University of South Dakota-Springfield	Springfield
TN	Aquinas Junior College	Nashville
	Austin Peay State University	Clarksville
	Belmont College	Nashville
	Carson-Newman College	Jefferson City
	Chattanooga State Technical Community College	Chattanooga

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Christian Brothers College	Memphis
	Cleveland State Community College	Cleveland
	Columbia State Community College	Columbia
	Covenant College	Lookout Mountain
	Cumberland College	Lebanon
	David Lipscomb College	Nashville
	Dyersburg State Community College	Dyersburg
	East Tennessee State University	Johnson City
	Fisk University	Nashville
	Freed-Hardeman College	Henderson
	Free Will Baptist Bible College	Nashville
	George Peabody College for Teachers	Nashville
	Hiwassee College	Madisonville
	Jackson State Community College	Jackson
	King College	Bristol
	Knoxville College	Knoxville
	Lambuth College	Jackson
	LeMoyne-Owen College	Memphis
	Martin College	Pulaski
	Memphis State University	Memphis
	Middle Tennessee State University	Murfreesboro
	Milligan College	Milligan College
	Nashville State Technical Institute	Nashville
	Roane State Community College	Harriman
	Shelby State Community College	Memphis
	State Technical Institute at Memphis	Memphis
	Steed College	Johnson City
	Tennessee Technological University	Cookeville
	Tennessee Wesleyan College	Athens
	University of the South	Sewanee
	University of Tennessee	Knoxville
	University of Tennessee Center for Health Sciences	Memphis
	University of Tennessee at Martin	Martin
	University of Tennessee at Nashville	Nashville
	Vanderbilt University	Nashville
	Volunteer State Community College	Gallatin
	Walters State Community College	Morristown
TX	Abilene Christian University	Abilene
	Alvin Community College	Alvin
	Amarillo College	Amarillo
	American Technological University	Killeen
	Angelina College	Lufkin
	Angelo State University	San Angelo
	Austin College	Sherman
	Austin Presbyterian Technological Seminary	Austin
	Baylor College of Dentistry	Dallas
	Baylor College of Medicine	Houston
	Baylor University	Waco
	Bee County College	Beeville
	Blinn College	Brenham
	Brazosport College	Lake Jackson
	Cisco Junior College	Cisco
	Clarendon College	Clarendon
	College of the Mainland	Texas City
	Concordia Lutheran College	Austin
	Cooke County College	Gainesville
	Dallas Bible College	Dallas
	Dallas Christian College	Dallas
	Dallas County Community College District	
	Eastfield College	Mesquite
	El Centro College	Dallas
	Mountain View College	Dallas
	Richland College	Dallas

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Dallas Theological Seminary	Dallas
	Del Mar College	Corpus Christi
	DeVry Institute of Technology	Dallas
	East Texas Baptist College	Marshall
	East Texas State University	Commerce
	El Paso Community College	El Paso
	Frank Phillips College	Borger
	Galveston College	Galveston
	Grayson College	Denison
	Gulf Coast Bible College	Houston
	Hardin-Simmons University	Abilene
	Henderson County Junior College	Athens
	Houston Baptist University	Houston
	Houston Community College	Houston
	Howard College at Big Spring	Big Spring
	Howard Payne University	Brownwood
	Huston-Tillotson College	Austin
	Incarnate Word College	San Antonio
	Jacksonville College	Jacksonville
	Jarvis Christian College	Hawkins
	Kilgore College	Kilgore
	Lamar University	Beaumont
	Laredo Junior College	Laredo
	Lee College	Baytown
	Le Tourneau College	Longview
	Lon Morris College	Jacksonville
	Lubbock Christian College	Lubbock
	McLennan Community College	Waco
	McMurry College	Abilene
	Midland College	Midland
	Midwestern State University	Wichita Falls
	Navarro College	Corsicana
	North Harris County College	Houston
	North Texas State University	Denton
	Odessa College	Odessa
	Our Lady of the Lake University of San Antonio	San Antonio
	Pan American University	Edinburg
	Panola Junior College	Carthage
	Ranger Junior College	Ranger
	Rice University	Houston
	Saint Edward's University	Austin
	Sam Houston State University	Huntsville
	San Antonio College	San Antonio
	San Jacinto College	Pasadena
	Schreiner College	Kerrville
	Southern Bible College	Houston
	Southern Methodist University	Dallas
	South Plains College	Levelland
	South Texas College of Law	Houston
	Southwestern Assemblies of God College	Waxahachie
	Southwestern Baptist Theological Seminary	Fort Worth
	Southwestern Christian College	Terrell
	Southwestern Union College	Keene
	Southwestern University	Georgetown
	Southwest Texas State University	San Marcos
	Stephen F. Austin State University	Nacogdoches
	Tarleton State University	Stephenville
	Tarrant County Junior College-Northeast Campus	Hurst
	Tarrant County Junior College-Northwest Campus	Fort Worth
	Tarrant County Junior College-South Campus	Fort Worth
	Texarkana College	Texarkana
	Texas A & I University	Kingsville

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Texas A & I University-Corpus Christi	Corpus Christi
	Texas A & I University-Laredo	Laredo
	Texas A & M University-Main Campus	College Station
	Texas A & M University Moody College of Marine Sciences and Maritime Resources	Galveston
	Texas Christian University	Fort Worth
	Texas College	Tyler
	Texas Lutheran College	Seguin
	Texas Southmost College	Brownsville
	Texas State Technical Institute-James Connally Campus	Waco
	Texas State Technical Institute-Mid-Continent Campus	Amarillo
	Texas State Technical Institute-Rio Grande Campus	Harlingen
	Texas Tech University	Lubbock
	Texas Wesleyan College	Fort Worth
	Texas Woman's University	Denton
	Trinity University	San Antonio
	Tyler Junior College	Tyler
	University of Dallas	Irving
	University of Houston-Main Campus	Houston
	University of Houston-Clear Lake City	Houston
	University of Houston-Victoria Campus	Victoria
	University of Texas-Arlington	Arlington
	University of Texas-Austin	Austin
	University of Texas at Dallas	Richardson
	University of Texas-El Paso	El Paso
	University of Texas Health Science Center at Dallas	Dallas
	University of Texas Health Science Center at Houston	Houston
	University of Texas Medical Branch at Galveston	Galveston
	University of Texas-San Antonio	San Antonio
	Vernon Regional Junior College	Vernon
	Victoria College	Victoria
	Weatherford College	Weatherford
	Western Texas College	Snyder
	West Texas State Universtiy	Canyon
	Wharton County Junior College	Wharton
	Wiley College	Marshall
UT	Brigham Young University	Provo
	Stevens Henager College	Ogden
	University of Utah	Salt Lake City
	Utah Higher Education System Office	
	University of Utah	Salt Lake City
	Utah State University	Logan
	Southern Utah State College	Cedar City
	Weber State College	Ogden
	College of Eastern Utah	Price
	Dixie College	Saint George
	Snow College	Ephraim
	Utah Technical College at Salt Lake City	Salt Lake City
	Westminster College	Salt Lake City

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
VT	Champlain College	Burlington
	Johnson State College	Johnson
	Lyndon State College	Lyndonville
	Marlboro College	Marlboro
	Middlebury College	Middlebury
	Norwich University	Northfield
	Saint Michael's College	Winooski
	School for International Training	Brattleboro
	Southern Vermont College	Bennington
	Trinity College	Burlington
	University of Vermont and State Agriculture College	Burlington
	Vermont Institute of Community Involvement	South Burlington
	Vermont Technical College	Randolph Center
	Windham College	Putney
VA	Averett College	Danville
	Bridgewater College	Bridgewater
	College of William and Mary	Williamsburg
	Eastern Mennonite College	Harrisonburg
	Eastern Virginia Medical School	Norfolk
	Emory and Henry College	Emory
	Ferrum College	Ferrum
	Hampton Institute	Hampton
	Institute of Textile Technology	Charlottesville
	J. Sargeant Reynolds Community College	Richmond
	Madison University	Harrisonburg
	Old Dominion University	Norfolk
	Radford College	Radford
	Randolph-Macon College	Ashland
	Randolph-Macon Woman's College	Lynchburg
	Saint Paul's College	Lawrenceville
	University of Virginia	Charlottesville
	Virginia Intermont College	Bristol
	Virginia Military Institute	Lexington
	Virginia Polytechnic Institute and State University	Blacksburg
	Virginia Wesleyan College	Norfolk
	Washington and Lee University	Lexington
	Wytheville Community College	Wytheville
WA	Bellevue Community College	Bellevue
	Big Bend Community College	Moses Lake
	Centralia College	Centralia
	Central Washington State College	Ellensburg
	Clark College	Vancouver
	Columbia Basin Community College	Pasco
	Cornish School of Allied Arts	Seattle
	Eastern Washington State College	Cheney
	Evergreen State College	Olympia
	Fort Steilacoom Community College	Tacoma
	Fort Wright College of the Holy Names	Spokane
	Gonzaga University	Spokane
	Grays Harbor College	Aberdeen
	Green River Community College	Auburn
	Highline Community College	Midway
	Lower Columbia College	Longview
	Lutheran Bible Institute of Seattle	Seattle
	Northwest College of the Assemblies of God	Kirkland
	Olympia Technical Community College	Olympia
	Olympic College	Bremerton
	Pacific Lutheran University	Tacoma
	Peninsula College	Port Angeles

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Seattle Community College District	
	North Seattle Community College	Seattle
	Seattle Community College-Central Campus	Seattle
	Seattle Community College-South Campus	Seattle
	Seattle University	Seattle
	Shoreline Community College	Seattle
	Skagit Valley College	Mount Vernon
	Tacoma Community College	Tacoma
	University of Puget Sound	Tacoma
	Walla Walla College	College Place
	Walla Walla Community College	Walla Walla
	Washington State Community College-District 5	
	Edmonds Community College	Lynnwood
	Everett Community College	Everett
	Washington State Community College-District 17	
	Spokane Falls Community College	Spokane
	Washington State University	Pullman
	Wenatchee Valley College	Wenatchee
	Western Washington State College	Bellingham
	Whatcom Community College	Bellingham
	Whitman College	Walla Walla
	Whitworth College	Spokane
	Yakima Valley College	Yakima
WV	Alderson Broaddus College	Phillippi
	Beckley College	Beckley
	Bethany College	Bethany
	Bluefield State College	Bluefield
	Concord College	Athens
	Davis and Elkins College	Elkins
	Glenville State College	Glenville
	Marshall University	Huntington
	Morris Harvey College	Charleston
	Parkersburg Community College	Parkersburg
	Potomac State College	Keyser
	Salem College	Salem
	West Liberty State College	West Liberty
	West Virginia Institute of Technology	Montgomery
	West Virginia University	Morgantown
	Wheeling College	Wheeling
WI	Alverno College	Milwaukee
	Beloit College	Beloit
	Blackhawk Technical Institute	Janesville
	Cardinal Stritch College	Milwaukee
	Carroll College	Waukesha
	Carthage College	Kenosha
	Concordia College	Milwaukee
	District One Technical Institute	Eau Claire
	Edgewood College	Madison
	Fox Valley Technical Institute	Appleton
	Gateway Technical Institute	Kenosha
	Holy Redeemer College	Waterford
	Institute of Paper Chemistry	Appleton
	Lakeshore Technical Institute	Cleveland
	Lawrence University	Appleton
	Madison Area Technical College	Madison
	Madison Business College	Madison
	Marian College of Fond Du Lac	Fond Du Lac
	Marquette University	Milwaukee
	Mid-State Technical Institute	Wisconsin Rapids
	Milton College	Milton

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Milwaukee Area Technical College	Milwaukee
	Moraine Park Vocational, Technical and Adult Education Institute	Fond Du Lac
	Mount Mary College	Milwaukee
	Mount Senario College	Ladysmith
	Nicolet College and Technical Institute	Rhinelander
	North Central Technical Institute	Wausau
	Northeast Wisconsin Technical Institute	Green Bay
	Northland College	Ashland
	Ripon College	Ripon
	Saint Norbert College	De Pere
	Silver Lake College	Manitowoc
	Southwest Wisconsin Vocational-Technical Institute	Fennimore
	University of Wisconsin-Green Bay	Green Bay
	University of Wisconsin-Madison	Madison
	University of Wisconsin-Milwaukee	Milwaukee
	University of Wisconsin-System Office	Madison
	Viterbo College	La Crosse
	Waukesha County Technical Institute	Pewaukee
	Western Wisconsin Technical Institute	La Crosse
WY	Casper College	Casper
	Eastern Wyoming College	Torrington
	Laramie County Community College	Cheyenne
	Northwest Community College	Powell
	Sheridan College	Sheridan
	University of Wyoming	Laramie
	Western Wyoming Community College	Rock Springs